THE ROLE OF PHYSICAL ACTIVITY, WEIGHT STATUS, AND PSYCHOSOCIAL FACTORS IN MENOPAUSAL WELL-BEING AND DIABETES PREVENTION IN MIDDLE-OLDER WOMEN

by

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(Under the Direction of Ellen M. Evans and Janet Buckworth)

ABSTRACT

PURPOSE: Compared to male counterparts, middle-older women are disproportionately affected by physical inactivity, obesity, chronic conditions, and psychosocial distress and these factors may compromise sexual and menopausal well-being and increase risk for type II diabetes mellitus (T2DM). Despite the known health benefits of exercise (EX) and (PA), the integrated effects of EX/PA, health status and psychosocial factors on sexual/menopausal well-being has not been well-characterized. Less is known about EX/PA behaviors in the context of Diabetes Prevention Program (DPP) success in this cohort. **METHODS:** Two datasets afforded a secondary data analyses in middle-older women: 1) a cross-sectional study exploring EX/PA, and psychosocial outcomes, and 2) a one-year community DPP intervention. Relatedly, the aims were to: 1) examine the influence of moderate-vigorous PA (MVPA) and adiposity on sexual and menopausal well-being, controlling for health status and psychosocial well-being, and 2) determine the effect of social support (SS) and EX/PA benefits and barriers on improvements in EX/PA behaviors and subsequent weight loss in response to the DPP. **RESULTS:** For aim 1, participants (n=68) health status and depressive symptoms negatively impacted sexual and menopausal well-being (standardized Beta coefficients range = .22-.56, all $P < .05$). Alternatively, MVPA did not appear to play a role in sexual well-being beyond health status or depression scores (All P for MVPA coefficients > .05). For aim 2, women (n=29) experienced clinically meaningful weight loss (6.3%, $P < .05$), and moderate PA and MVPA increased, albeit effect sizes were small and insignificant ($P > .05$). Increased SS from family participation and fewer barriers were associated with increased vigorous PA (r =.52 and -.39, respectively, both $P < .05$). Physical performance and preventive health were the highest perceived benefits, whereas the exertion for EX/PA behaviors was the greatest barrier ($P < .05$). **CONCLUSION**: Health status and depressive symptoms negatively impact sexual and menopausal well-being in middle-older women. A community delivered DPP is effective for weight loss and improves perceived SS for EX/PA. The impact of the DPP on EX/PA behaviors is not robust; however, perceptions of family participation and fewer barriers to EX/PA appear to increase vigorous PA behaviors.

INDEX WORDS: Physical Activity, Adiposity, Menopausal Well-being, Psychosocial Well-being, Diabetes Prevention, Middle-aged, Older Women

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DEDICATION

To my life partner, Frank, the most resilient, thoughtful, and creative person I have ever known and who has always been there to hold my hand and encourage me to thrive personally and academically. To my parents, Mami Sonia and Pa Alexis, whose legacy of love, kindness, honesty, and hard work keeps guiding me until today. To my siblings, Andrés y Alberto, your confidence in me helped me persevere. To my in-laws, Clari, Don Walter, Wally, Evelyn, Guis, and José, your endless kindness and support motivated me along the way. To my beloved nieces and nephews, Jime, Luis Ángel, Gael, Vale, Yari, and Amelia, whose joy and innocence bring me light in the most difficult times. I am incredibly grateful to be your Tía Isa ¡Este inmenso logro es de ustedes, los amo! (Translation: This immense accomplishment is yours; I love you!).

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TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1. Significance and Brief Overview

Global demographics are changing with many women coinciding with what is often identified as the midlife age category (aged 45-64 years) (Colby, Ortman, & Bureau, 2015; UN, 2019b). Midlife is a pivotal period in the female life course given the concomitant hormonal (e.g., menopause), physical, and psychological changes amidst numerous common challenges in the social and personal domains whereby poor lifestyle choices may significantly impact health and well-being (Chiu, Tsao, & Lin, 2020; Grundy & Henretta, 2006; NAMS, 2020; WHO, 2007). Physical inactivity, unhealthy weight status, prevalence of chronic conditions, and psychosocial distress (i.e., depression, anxiety) are common among early menopausal women and are linked to reductions in sexual well-being and menopause-specific quality of life (MENQOL).

Sexual well-being and MENQOL are compromised in females during the middle-aged period for multi-factorial reasons that have not been completely characterized (Carcelén-Fraile et al., 2020). Indeed, some conditions and risk factors that are associated with male sexual dysfunction such as obesity, comorbidities, and psychological factors (e.g., depressive symptoms and stress) also appear to be associated with poor sexual well-being in females (Corona et al., 2020; Markos, 2012). This is a salient issue as current trends confirm the existence of health disparities with middle-older female populations being more likely than men to be overweight/obese, have multiple chronic conditions, use more prescription medications, and experience depressive symptoms (Boersma, Black, & Ward, 2020; Buttorff, Ruder, & Bauman, 2017; Goodman, Posner, Huang, Parekh, & Koh, 2013; NCHS, 2021; Ohkuma, Peters, & Woodward, 2018; WHO, 2007; Xiang, 2016), which collectively increases the risk of disease-related disability. Furthermore, this is of concern as women are known to have longer life expectancies thus the compromised well-being will burden women for more years of their lives.

There is a myriad of well-established benefits attributed to exercise (EX) and habitual physical activity (PA) for physical and psychosocial health (USDHHS, 2018a). Thus, it is theoretically plausible that EX/PA behavior would positively influence midlife women's sexual well-being and MENQOL given the recognized improvements of habitual EX/PA on adiposity, chronic disease prevention, and psychosocial well-being (Dubnov, Brzezinski, & Berry, 2003; Elavsky, 2009; Mirzaiinjmabadi, Anderson, & Barnes, 2006; Reed et al., 2014). However, the integration of these variables remains incompletely characterized in this cohort. Thus, as multimorbidity can be difficult to manage, particularly when coupled with depressive symptoms and stress (Buttorff et al., 2017), and given the numerous theoretical links among EX/PA and adiposity as independent variables of interest, it is salient to assess the impact of these health-related outcomes on sexual and menopausal well-being in a more integrated manner. In particular, the utilization of research-level measures to assess EX/PA behavior (i.e., objective; accelerometry) and adiposity (i.e., dual energy x-ray absorptiometry; DEXA), for this integrated investigation is also warranted.

Overweight/obesity along with poor health behaviors, especially poor diet quality and physical inactivity, are major threats to public health, in large part due to their contribution to type II diabetes mellitus (T2DM) (Hruby & Hu, 2015; Mobbs & Hof, 2010). As with obesity and psychosocial distress, the prevalence of T2DM also disproportionately affects middle-older women's well-being. Notably, females are at greater risk of developing T2DM with advancing age, and subsequently at greater risk for disabling and life-threatening chronic diseases associated with T2DM (e.g., cancer, cardiovascular disease) compared to male counterparts (Ohkuma et al., 2018; Ohkuma, Peters, & Woodward, 2019; Peters, Huxley, & Woodward, 2014b). Similarly, EX/PA is an effective strategy for weight management and the prevention of T2DM for middle-older women (ACSM/ADA, 2010; ADA, 2020; Anton, Karabetian, Naugle, & Buford, 2013), especially as a part of evidence-based initiatives targeting lifestyle change such as the CDC-recognized Diabetes Prevention Program (DPP) and its associated curriculum called Prevent T2 (CDC, 2020b; Knowler et al., 2002; Knowler et al., 2009).

The latest Prevent T2 version, released in 2016, has an increased focus on EX/PA compared to previous versions. This revised version is also grounded in Social Cognitive Theory and implements health education, goal setting, social support, and benefits and barriers related strategies to enhance EX/PA behaviors. However, the systematic and quantitative study of these psychosocial variables in the context of DPP/Prevent T2 implementation is scarce, particularly in middle-older women who represent the most common demographic of participants in the DPP. Notably, understanding how psychosocial factors influence EX/PA behavior change and weight loss will ultimately inform DPP implementation tailored for effectiveness in middle-older overweight/obese women known to be vulnerable to T2DM and many other threats to well-being.

In this context, the current dissertation is nontraditional in that it utilized a secondary data analysis approach and two different existing datasets albeit both resulting manuscripts centered on EX/PA and middle-older women's health and well-being. Chapter 2 (Literature Review A) of this dissertation summarizes background literature regarding: a) our social demographic changes, why midlife is often a pivotal period of a woman's life and challenging to sexual and menopausal well-being and b) the role of EX/PA and adiposity in such dynamic to frame the first manuscript, which used a cross-sectional research design. The parent study of the first manuscript was conducted in the UGA Body Composition and Metabolism Lab prior to the COVID-19 pandemic. Next, in Chapter 2 (Literature Review B) a summarized background of the following topics regarding middle-older women is discussed: a) the health burden of diabetes, b) the national DPP and the Prevent T2 curriculum, and c) primary psychosocial constructs including EX/PA SS and benefits and barriers, as keys for DPP success and EX/PA behavior change to provide theoretical framework for the second manuscript, which used an interventional research design. The onset of the COVID-19 pandemic occurred during the implementation of the parent project of the second manuscript of this dissertation and continued as a global situation for the remainder of the project. Due to that, the project was converted from in-person to distance education delivery after the second week of March 2020 with data collection being completed in March 2021.

1.2. Primary Aims

Therefore, the overarching aim of the current dissertation is to examine the role of EX/PA behaviors and psychosocial factors on middle-older women's health and well-being related outcomes.

Primary Aim 1: To examine the relative influence of accelerometer-measured moderate-to-vigorous intensity PA (MVPA) and adiposity on sexual and menopausal well-being in midlife postmenopausal women while controlling for health status (total number of comorbidities and medications) and psychosocial wellbeing (depressive symptoms and perceived stress scores).

Hypothesis: It was hypothesized that higher levels of daily MVPA and lower adiposity would be associated with more favorable sexual well-being and MENQOL. Because it was anticipated that health status and psychosocial well-being, especially depressive symptoms, would influence sexual and menopausal well-being, these variables were controlled in the analysis. In this regard, it was hypothesized that although higher scores in these covariates would inversely predict well-being, the predictive influence of both MVPA and adiposity on sexual well-being and MENQOL would remain, due to the strength of their relative contribution to the dependent variables of interest.

Primary Aim 2: To determine the influence of perceived SS and Benefits and Barriers on improvements in EX/PA behaviors and whether these improvements were linked to change in body weight in response to a one-year Cooperative Extension Services (CES) delivered DPP in middle-older women.

Hypothesis: It was hypothesized that those women who perceived greater SS and Benefits and fewer Barriers would experience greater increases in EX/PA behavior in response to the intervention. Subsequently, it was hypothesized that greater improvements in EX/PA behavior would lead to greater weight loss success in response to the program.

CHAPTER 2

LITERATURE REVIEW

The current dissertation utilized a secondary data analysis approach from two different projects albeit both resulting manuscripts centered on EX/PA and middle-older women's health and well-being. Thus, two different sections are provided in this chapter as Literature Review A and Literature Review B to summarize background literature and provide theoretical framework for Manuscript 1 (cross-sectional) and Manuscript 2 (intervention), respectively.

2.1. Literature Review A

2.1.1. Profiling Midlife Women in the United States

Middle-older women are a growing sector of the population that faces unique challenges to well-being which can ultimately compromise a healthy aging experience. Assuming an increase in life expectancy, a decline in fertility rates, and modest increases in the overall rate of net international migration; an average increase rate of 2.1 million people per year is projected in the United States population by 2060 (Colby et al., 2015). With these changes in the shape of population pyramid (UN, 2019a, 2019b), the population of middle-aged individuals, aged 45-60 years in 2060 is projected to be just over 100 million, up from 83 million in 2014 (Colby et al., 2015). This specific portion of the population coincides with what is often identified as the midlife age category (Fraser, Maticka-Tyndale, & Smylie, 2004; USCB, 2020; USH, 2015).

Midlife is a critical period in the female life course given the concomitant physical and psychological changes amidst numerous common challenges in the social and personal domains that collectively often compromise well-being (Grundy & Henretta, 2006; NAMS, 2020). This is a salient issue as women are known to have longer life expectancies than men and, especially at midlife, women play a central role in the lives of those who are younger and older at home, in the workplace, and society at large (Evans & Castillo-Hernández, 2020; Krauss Whitbourne & Whitbourne, 2011; Parker & Patten, 2013; WHO, 2007). For example, women aged 40-59 years are more likely than men to indicate that both their aging parents and their grown children rely on them for emotional support, a situation often referred to as the "sandwich generation" (Parker & Patten, 2013).

For women, some unique challenges at midlife include physiological (e.g., changes in sex hormones, menopausal transition) (NAMS, 2020) and social adjustments primarily impacting physical and psychosocial health domains that often convert to a chronic condition diagnosis (Robbins, Engels, Pfeiffer, & Shiels, 2015; Xiang, 2016). For example, feelings of stress and anxiety due to family demands can precede the onset of depressive disorders that peak during midlife. Blood glucose that was at the prediabetic level now reaches the diabetes range. Blood pressure that has been rising is now in a pernicious level, and medications are now prescribed (Martin, Freedman, Schoeni, & Andreski, 2010).

Notably, from a health disparity perspective, middle-aged women are at a higher risk for obesity, chronic stress, and numerous chronic conditions, including diabetes and depression, compared to their male counterparts (Ohkuma et al., 2018, 2019; WHO, 2007). This is salient as there is a greater likelihood of increased symptoms of depression linked with menopausal status relative to pre-menopause, even among women without a history of depression (Mulhall, Andel,

& Anstey, 2018). Moreover, several common symptoms of perimenopause (e.g., night sweats, energy changes) also co-occur and overlap with depressive symptoms and perceived stress. In fact, depression is one of the leading causes of disease-related disability in women with women being nearly twice as likely as men to suffer from an episode of depression (Sassarini, 2016). Therefore, the burden of depression and the menopause transition on women's life may be additive (Maki et al., 2019; Prairie et al., 2015; Uguz, Sahingoz, Gezginc, & Ayhan, 2011), which collectively represents a significant burden on their well-being.

On average, middle-older women use more prescription medications (e.g., blood pressure and cholesterol lowering agents, thyroid replacement therapy, psychoactive drugs), compared to their male counterparts. Accordingly, 33.8% of males and 38.9% of females aged 45-64 years report taking three or more prescription drugs, a disparity that continues with advancing age (65.5% of males versus 67.1% of females aged 65 years and over) (NCHS, 2021). Notably, it is not just the chronic disease or condition that can hamper women's well-being; often, the medications used for treatment can have negative implications as well. For example, blood pressure medications often cause fatigue, while sexual dysfunction is an important under-estimated side effect of antidepressant drugs (Chiesa, Serretti, Calati, & de Ronchi, 2009; Parish et al., 2019). Some evidence also suggests that the complex interrelationship between women's chronic conditions/medications and depressive symptoms has yet to be determined to better understand if having chronic conditions increases the prevalence of depression or whether depressive symptoms increase the risk of having a chronic condition, and how such dynamic overlaps with/relates to health behaviors and well-being (CDC, 2012; NIMH, 2021; Xu, Mishra, & Jones, 2019). This is of essential interest given the aforementioned unique changes for midlife women that often contribute to metabolic and psychosocial challenges that lead to a multimorbid condition and a reduced chronic disease-free life expectancy that eventually might hinder women's autonomy and independence (Arterburn et al., 2012; Chen & Sloan, 2015; Garber et al., 2010; Kapoor, Collazo-Clavell, & Faubion, 2017; Karvonen-Gutierrez & Kim, 2016; Lebrun et al., 2006; Mirhaghjou, Niknami, Moridi, Pakseresht, & Kazemnejad, 2016; USH, 2015; WHO, 2007).

2.1.2. Sexual Well-being as a Core Component of Quality of Life as Women Age

Although the concept of wellness has been common in our society for numerous decades, a more contemporary term is well-being. The core concept is that well-being, a relative state, is where one maximizes physical, mental, and social functioning in a supportive environment to live a full, satisfying, and productive life (Kobau, Sniezek, Zack, Lucas, & Burns, 2010; Moriarty David, Zack Mathew, & Kobau, 2003). The recognition that well-being greatly impacts health status and quality of life in an integrated manner has prompted numerous national health agencies, including the World Health Organization, to address well-being directly (WHO, 2019). In the US, the Healthy People 2020 health agenda highlighted the inclusive nature of physical, mental, and social functioning domains of well-being and included it as one of the initiative's four overarching goals defined as *promoting quality of life, healthy development, and health behaviors across all life stages* (Chen & Sloan, 2015; ODPHP, 2020). Similarly, sexuality and sexual well-being are core components of human life that are connected with both physical and mental health and are relevant throughout the entire lifespan and not just during the reproductive years (Armeni et al., 2016; CDC, 2010; OSG, 2001). Sexual well-being decline during the middle-age period is bidirectionally associated with the development or aggravation of mental health conditions leading to deterioration in women's quality of life (Carcelén-Fraile et al., 2020).

Physical issues associated with sexual well-being need to be addressed; however, it is commonly recognized that psychosocial constructs also have a significant impact on one's sexuality. Thus, sexual affect and cognition in the form of sexual attitudes and satisfaction, sexual motivation in the form of sexual interest, and changes associated with the menopause transition (e.g., vasomotor symptoms, vaginal dryness) have been used previously to characterize sexual well-being (Fraser et al., 2004; Santos-Iglesias, Byers, & Moglia, 2016). Given that menopause-associated changes may disrupt emotional, physical, and social aspects of a woman's life, menopause specific quality of life (MENQOL) should also be considered a salient construct impacting the midlife experience of sexuality and relatedly, sexual well-being (Tsai, Yeh, & Hwang, 2011; Utian, 2007).

MENQOL refers to the extent that the physical, emotional, and social aspects of a woman's life are intact and not adversely affected by their postmenopausal period experience. Thus, MENQOL encompasses vasomotor (e.g., hot flashes, night sweats), psychosocial (e.g., dissatisfaction with personal life, feeling of wanting to be alone), physical (e.g., decrease in physical stamina, feeling bloated, involuntary urination, breast tenderness), and sexual (e.g., decrease in sexual desire, avoiding intimacy) domains (Hilditch et al., 2008; Lewis, Hilditch, & Wong, 2005). Research regarding factors that hinder or enhance sexual well-being and MENQOL are highly variable across research interests and populations; however, MENQOL, with a special interest in the sexuality of women at midlife has received insufficient attention in general (Fraser et al., 2004).

2.1.3. Integrating Physical Activity Behavior and Adiposity and its Potential Link to Sexual and Menopausal Well-being

Besides the aforementioned unique challenges faced by women, the presence of gradual weight gain that intensifies at midlife certainly aggravates the compromised well-being situation (Davis et al., 2012; Jaspers et al., 2015). Changes in body composition are influenced by environmental, socioeconomic, genetic, hormonal, and behavioral factors such as EX/PA and nutrition, as well as natural aging processes. Age-related increases in adiposity and decrease in muscle mass along with poor health behaviors are becoming a major threat to public health due to its contribution to prevalence of obesity, which in turn and especially in women, may lead to disability and poor well-being and quality of life (Hruby & Hu, 2015; Mobbs & Hof, 2010). Accordingly, numerous studies have demonstrated how metabolic dysregulation associated with overweight and obesity can worsen the decline in physical function associated with aging (Anton et al., 2013; Arterburn et al., 2012; Davison, Ford, Cogswell, & Dietz, 2002; Martin et al., 2010), especially in combination with obese sarcopenia (i.e., progressive loss of muscle mass and strength along with an increased adiposity) (Kalinkovich & Livshits, 2017; Rejeski, Marsh, Chmelo, & Rejeski, 2010).

The high prevalence of overweight and obesity among females is well established, with the mean age among obese women being between 44 and 47 years (Wang, Colditz, & Kuntz, 2007), which is early midlife. Additionally, age and sex/gender also have implications for the prevalence of severe obesity (BMI $\geq$ 40 kg·m-2) for which the prevalence almost doubles in women (8.3%) compared to men (4.4%), and is highest among the middle-age group (7.7%) compared with 20- to 39-year-olds (5.6%) and adults aged 60 years or older (5.6%) (Ogden, Carroll, Kit, & Flegal, 2014). Health disparity by sex remains when reporting a significant increase in obesity from 31.5% to 38.1% among women aged 60 years in the same study.

Some conditions and risk factors that are associated with male sexual dysfunction such as obesity, comorbidities, medications, and psychological distress (e.g., depression and stress) also appear to be associated with poor sexual well-being in females (Corona et al., 2020; Markos, 2012). Sexual well-being is compromised in females during the middle-aged period for multi-factorial reasons, including the menopausal transition (Carcelén-Fraile et al., 2020). Increased weight status also may adversely affect sexual function (Davis et al., 2012), probably due to a "domino" effect on overall health and other menopausal symptoms (Gartoulla, Worsley, Bell, & Davis, 2018; Genazzani, Gambacciani, & Simoncini, 2007), although this is incompletely characterized in the literature. For example, Pace et al. (2009) found that a BMI greater than 30 $kg \cdot m^{-2}$ was inversely associated with sexual well-being as indicated by sexual satisfaction, arousal, orgasm, and lubrication, whereas sexual desire and pain were not correlated. Moreover, in a female overweight and diabetic cohort it has been elucidated that sexual dysfunction (e.g., loss of sexual interest, decrease in lubrication) appears to be more strongly related to psychological factors and depressed mood than to metabolic alterations per se (Kizilay, Gali, & Serefoglu, 2017).

Proper weight management that includes optimal levels of EX/PA is crucial in preventing declines in well-being and physical function in middle-older women (An & Shi, 2015). Indeed, a recent systematic review as well as the Physical Activity Guidelines (PAG) Advisory Committee Scientific Report also support that EX/PA, as a modifiable lifestyle choice, improves weight status and reduces the risk of age-related decline in physical functioning in an inverse graded manner (Dipietro et al., 2019; USDHHS, 2018a). Collectively, habitual EX/PA is likely an effective strategy to prevent loss of quality of life in middle-older women by attenuating the adverse effects of obesity on physical and psychosocial well-being, potentially through its impact on body composition (Koster et al., 2008; USDHHS, 2018a; Willis, Gao, Leonard, DeFina, & Berry, 2012). Although the beneficial effects of EX/PA are well established, typical middle-aged women often do not engage in such behaviors (Bennie, DeCocker, Teychenne, Brown, & Biddle, 2019; Du et al., 2019; El Hajj et al., 2020). Unfortunately, ~80% of middle-older women in the U.S. fail to meet the PAG for both aerobic and muscle strengthening activities, thus comprising one of the cohorts with the lowest proportion meeting the guidelines. Indeed, it is not only that middle-older women are insufficiently active but that they also fail to engage in intense activities, with just 17.73% meeting the vigorous intensity plus muscle strengthening PAG through the leisure, household, and outdoor PA domains (Bennie et al., 2019; Schaal, Woonghee Lee, Egger, Nygaard, & Shaw, 2016).

It is theoretically plausible that EX/PA behavior would also positively influence midlife women's sexual and menopausal well-being given the recognized improvements of habitual EX/PA on adiposity and overall psychosocial well-being (Dubnov et al., 2003; Elavsky, 2006, 2009; Kishida & Elavsky, 2016; Mirzaiinjmabadi et al., 2006; Reed et al., 2014). Favorable associations among PA behavior, sexual well-being, and MENQOL symptoms and dose-response cardiometabolic adaptations and weight control in middle-aged women have been reported (Mendoza et al., 2016; Miner, Esposito, Guay, Montorsi, & Goldstein, 2012; USDHHS, 2018a). Recent evidence utilizing accelerometry proposes that greater PA, especially of vigorous intensity, is associated with better health-related quality of life, particularly in the physical domain (Koolhaas et al., 2018; Marín-Jiménez, Ruiz-Montero, De la Flor-Alemany, Aranda, & Aparicio, 2020). Koolhaas et al. (2018) aggregate that specific activity types such as sports and cycling contributed more to health-related quality of life compared to walking and domestic work.

A vast majority of the menopausal well-being literature has particularly focused on EX/PA (Bachmann, 2015; A. Daley, Stokes-Lampard, Thomas, & MacArthur, 2014; A. J. Daley et al., 2015; Shepherd-Banigan et al., 2017; Sternfeld & Dugan, 2011) or weight status (Huang et al., 2010) and vasomotor symptoms. In brief, it has been theorized that because EX/PA raises body temperature it could increase the occurrence of vasomotor symptoms (Mansikkamäki et al., 2016; Thurston, Santoro, & Matthews, 2012). Alternatively, EX/PA improves thermoregulation by inducing central ß-endorphin production/releasing through activation of large muscle groups during menopause (when the production of estrogen is drastically reduced) (Berin et al., 2019; Lindh-Åstrand, Nedstrand, Wyon, & Hammar, 2004). However, the integrated dynamic among EX/PA, weight/health status, sexual, and menopausal well-being has not been well-established.

Although positive effects of EX/PA for nonhormone management of symptoms that might impact sexual well-being and improve MENQOL in middle-life women have been reported (Elavsky, 2006; Ennour-Idrissi, Maunsell, & Diorio, 2015; Fontvieille, Dionne, & Riesco, 2017; Mansikkamäki et al., 2016; Mansikkamäki et al., 2015; Mendoza et al., 2016; Reed et al., 2014), a recent systematic review on the effects of EX/PA on sexual functioning and quality of sexual life in peri- and postmenopausal women suggests that the effects of moderate-to-vigorous intensity PA (MVPA) on sexual well-being remains incompletely characterized. The same review indicated that most study designs focus on mind-body disciplines and pelvic floor training, the latter due to the known links with sexual function and urinary incontinence (Carcelén-Fraile et al., 2020). Conversely, aerobic exercises showed inconsistent results and resistance training did not seem to convey any benefits, and concluded that although positive effects have been observed, further studies on this topic are needed to better elucidate the interrelationships among midlife women's physical and psychosocial characteristics associated with sexual well-being (Carcelén-Fraile et al., 2020). Further research involving mature samples drawn from the larger community has also been encouraged. In this regard, it has been hypothesized that more mature women (e.g., middle-older) might show even larger differences in sexual experiences across the weight status spectrum (Wiederman & Hurst, 1998).

To date, most studies have examined the associations among EX/PA (mostly self-reported), weight status, sexual well-being, and MENQOL in midlife women in an independent fashion (Carcelén-Fraile et al., 2020; Mansikkamäki et al., 2016; Mansikkamäki et al., 2015; Marín-Jiménez et al., 2020; Mirhaghjou et al., 2016). As multimorbidity can be difficult to manage, particularly when coupled with depression and stress (Buttorff et al., 2017) and given the numerous theoretical links among EX/PA and adiposity as independent variables of interest, it is warranted to assess the predictive role of these health-related outcomes on sexual and menopausal well-being in a more integrated manner.

2.2. Literature Review B

2.2.1. The Public Health Burden of Type II Diabetes Mellitus

The National Diabetes Statistics Reports (2020) estimate that 34.5 million adults in the U.S. had diabetes in 2018 (NDSR, 2020). This prevalence is projected to increase to 39.7 million (13.9%) in 2030, and to 60.6 million (17.9%) in 2060. Accordingly, the number of people with diabetes aged 65 years or older would triple, increasing from 9.2 million in 2014 to 35.2 million in 2060, with women having the largest relative increases (Lin et al., 2018; USDHHS, 2011). Diabetes already imposes significant health and financial burdens on individuals with the disease, their families, the national health care system, and society at large (Lin et al., 2018). Annual deaths attributed to diabetes are projected to increase by 38% to 385,800 and total annual medical and societal costs to increase 53% to more than US$622 billion by 2030 (Rowley, Bezold, Arikan, Byrne, & Krohe, 2017). Perhaps more troubling, the U.S. diabetes forecasts project that nearly 107.7 million adults will have prediabetes by 2030 (Rowley et al., 2017), a condition that occurs when blood glucose concentrations are higher than normal but do not meeting the absolute definition of T2DM and represents a high-risk state for T2DM development (Bergman, 2013, 2014; Hadaegh et al., 2017).

Those who are diagnosed with prediabetes are more likely to develop T2DM, with about 5-10% progressing to T2DM each year (Tabák et al., 2012). Prediabetes is correlated with the simultaneous presence of β-cell dysfunction and insulin resistance and these abnormalities typically start before glycemic changes are detectable. Evidence shows associations of prediabetes with kidney diseases, neuropathies, diabetic retinopathy, and increased risk of macrovascular disease (Tabák et al., 2012; Wagner et al., 2021).

Despite nation-wide medical advances, meta-analytic evidence has shown that women's health span and aging experience remain disproportionately affected by disabling and life-threatening chronic diseases associated with T2DM including cancer (Ohkuma et al., 2018), dementia (Chatterjee et al., 2016), and stroke (Peters, Huxley, & Woodward, 2014a; Peters et al., 2014b), compared to male counterparts. Moreover, diabetic women have more than a 40% greater risk of incident coronary heart disease compared with diabetic men (Peters et al., 2014b). Sex differences in risk factor–disease-complications interrelationships have implications for patient management, treatment, and prevention and thus also have repercussions on efforts to quantify the burden of disease due to risk factors and challenges (Peters et al., 2014a, 2014b).

Studies quantifying the trends of prediabetes and T2DM prevalence indicate that the disease associated socioeconomic and health burden would continue to increase in the future if no actions were taken (Lin et al., 2018). Fortunately, T2DM can be prevented or delayed (Knowler et al., 2002; Knowler et al., 2009). According to Lin et al 2018, if the T2DM incidence rate was reduced by 20%, the number of people with diabetes would be reduced by 5 million in 2030 and 10 million in 2060. Significant population health measures, including increased availability of diabetes prevention programs, could help millions of adults, especially women, prevent or delay the progression to T2DM, thereby helping attenuate the aforementioned serious projections (Bean, Dineen, & Jung, 2020; Bean, Dineen, Locke, Bouvier, & Jung, 2020; Rowley et al., 2017).

2.2.2. The National Diabetes Prevention Program and The Prevent T2 Curriculum

Implementing effective prevention strategies to attenuate the increasing burden of T2DM is an urgent public health priority (Beaglehole et al., 2011; Rowley et al., 2017). Efforts that can be delivered within the community setting with a translational approach are needed (Kramer et al., 2009; Kramer, Miller, & Siminerio, 2014). Indeed, it is possible that the same proportion of 5-10% of persons at a prediabetic stage are able to convert back to normoglycemia (Tabák et al., 2012). Evidence-based initiatives targeting lifestyle change including the CDC-recognized Diabetes Prevention Program (DPP) are timely and are promising to prevent the onset of T2DM in high-risk participants (Cefalu et al., 2016; Knowler et al., 2009). The National DPP lifestyle change program is based on a landmark ~3-year DPP randomized clinical trial reporting that diabetes incidence in high-risk adults was reduced by 58% with an intensive lifestyle intervention targeting EX/PA and diet behaviors for weight loss. This study also highlighted that the lowest cumulative incidence of diabetes for the lifestyle group remained for at least 10 years compared to Metformin (the first line prescription) or a placebo (Knowler et al., 2002; Knowler et al., 2009).

It is well established that EX/PA are effective strategies for weight management and the prevention of T2DM for middle-older women (ACSM/ADA, 2010; ADA, 2020; Anton et al., 2013; Glechner et al., 2018). In particular, the utility of EX/PA to prevent T2DM is also well endorsed by the American College of Sports Medicine and the American Diabetes Association's whereby their joint position statement indicates that structured interventions that target lifestyle modification that fosters habitual EX/PA and modest weight loss, are warranted as they a) enable sustained behavior change, and b) significantly lower T2DM risk (ACSM/ADA, 2010). Thus, a specific curriculum addressing key lifestyle factors including PA and consuming a high-quality diet that is enabled through increased social support, self-efficacy, and self-monitoring, was created as a national effort to address the increasing burden of prediabetes and T2DM in the U.S. Although created in 2010, the most recent version released in 2016, Prevent T2, has an increased focus on EX/PA compared to previous versions and is built on lessons learned from the previous curriculum, including new topics proven to promote success (CDC, 2020b; Knowler et al., 2009).

The current curriculum promotes modest weight loss (5-7% of starting body weight) and increased EX/PA through a 12-month, two-phase lifestyle change program. Specifically, the Prevent T2 curriculum is grounded in Social Cognitive Theory and aims to help participants enhance overall social support, create strategies to improve their knowledge about benefits, and overcome perceived barriers (CDC, 2020b). The curriculum is a 1-year, two-phase program. Phase I, referred to as the core phase, includes a minimum of 16 consecutive sessions meeting once a week, followed by one session every two weeks for ~ 2 months, targeting different lifestyle modification topics. Phase II, referred to as the core maintenance phase, includes a minimum of 6 monthly meetings for the last 6 months. To achieve CDC recognition, the program must last for a full year and complete at least 22 modules. As examples, 10 sessions of the curriculum released in 2016 refers to EX/PA behavior change strategies and recommendations (e.g., *Track your Activity, Get More Active*, *Take a Fitness Break*) or contents directly related to being active for weight loss goals and sustainable T2DM prevention (e.g., *Burn More Calories than You Take In, Get Back on Track*) (CDC, 2020b; Knowler et al., 2002).

2.2.3. Social Support as a Strategy to Enhance Successful EX/PA Behavior Change in DPP Implementation in Middle-Older Participants

In order to maximize effectiveness, factors explaining adherence variability in response to lifestyle change interventions remains of high research interest (Buckworth, Dishman, O'Connor, & Tomporowski, 2013; Nigg, 2014; Shawley-Brzoska, 2019; Shawley-Brzoska & Misra, 2018), especially with regard to both adoption and maintenance of EX/PA (Buckworth et al., 2013). It is recognized that numerous social and personal influences may impact individuals' decisions regarding EX/PA behavior. Here, social support (SS) for EX/PA has been shown to be a relevant intervention target to explore at the individual level to inform what may impact lifestyle change endeavors for EX/PA and weight management (Buckworth, 2018; Shawley-Brzoska, 2019; Shawley-Brzoska & Misra, 2018). Social support is considered a central factor for initial and sustained EX/PA behavior change and can originate from different sources such as family and friends (Nigg, 2014), for example, by having a supportive partner or friend, or a companion with which to engage in EX/PA. Social support is also characterized as a facilitator to the uptake and maintenance of healthy behaviors by people at midlife (Kelly et al., 2016). Other forms of SS perceived as facilitators to EX/PA by middle-older participants are expressed by having a supporting physician or a healthcare provider (Kelly et al., 2016). In individuals with T2DM, those with higher SS scores have a 17% greater chance of avoiding physical inactivity (Morowatisharifabad, Abdolkarimi, Asadpour, Fathollahi, & Balaee, 2019).

A systematic review conducted by Spiteri et al. (2019) revealed that in middle-older adults, goal setting and SS are identified among the most important motivators of EX/PA participation, especially in middle-aged participants (Spiteri et al., 2019), both being key components of the Prevent T2 curriculum. Prior qualitative evidence in the context of DPP participants' perception of SS confirmed that goal-setting behavior is linked to family SS as participants tend to set goals to meet their family member's expectations and will strive to improve behaviors based on the support from their family or based on a family goal (Shawley-Brzoska, 2019). In this regard, support received from family members is key to overall program participation and healthy lifestyles. For example, it has also been suggested that participant's family history of prediabetes/diabetes and the risk factors involved can be typically discussed between family members as a sharing of experiences and motivating support for lifestyle change, along with motivations to use technology to track EX/PA between family members (Shawley-Brzoska, 2019). Lack of social support from family and friends would conversely affect EX/PA participation (Spiteri et al., 2019). In other cases, low engagement in EX/PA can be shaped by the presence of physical limitations in middle-older participants' family and/or friend companions (e.g., difficulties with walking) (Guell, Shefer, Griffin, & Ogilvie, 2016; Korkiakangas et al., 2011).

Similarly, participants' actions can be impacted by their friendships as they can keep each other accountable by commitment to exercise together or "keep each other going". In the context of the DPP, participants appear to form bonds with their friends that augment motivation for positive changes in health behaviors (Shawley-Brzoska, 2019). Qualitative studies in prediabetes educational interventions highlight that SS is a common theme identified as salient, as stated by this participant "Even the exercise – I didn't feel like a failure- we cheered each other on and supported each other" (Azzi et al., 2020). Understanding and addressing perceived SS are central to efforts to enhance DPP effectiveness, broadly defined (Nigg, 2014), and remains a core area of interest especially for the Prevent T2 program which is highly focused on EX/PA for effectiveness.

2.2.4. The Role of Perceived Benefits and Barriers in EX/PA Behavior Change in DPP Implementation in Middle-Older Participants

Perceived benefits from and barriers to EX/PA (Benefits and Barriers) are also recognized as salient personal/cognitive influences explaining adherence variability in response to lifestyle change interventions and remain of high research interest in order to maximize effectiveness (Buckworth et al., 2013; Nigg, 2014; Shawley-Brzoska, 2019). Benefits and Barriers have been identified as modifiable factors consistently associated with EX/PA. Despite Benefits and Barriers being examples of variables that should be tested in intervention research to see whether changes in them will result in changes in EX/PA behavior (Buckworth et al., 2013), the study of Benefits in the context of DPP implementation is particularly scarce. According to Kappor et al. (2017), in addition to counseling regarding lifestyle change, it is important to address the unique barriers to adoption of healthy lifestyle indicators in middle-older women (Kapoor et al., 2017). Moreover, Bean et al (2020) state that further research is needed to understand barriers specifically for women living with prediabetes since they may face different conditions including comorbidities, lack of symptoms, and risk perception compared to diagnosed diabetic counterparts.

Qualitative evidence suggests that health concerns not related to diabetes (e.g., arthritis-related chronic pain, sleep apnea, other chronic conditions) are common impediments to EX/PA participation (Casey, De Civita, & Dasgupta, 2010). The same study underscored participants perceptions that it is not just that health-concerns are a barrier but also that EX/PA opportunities such as public fitness centers often do not have the expertise to accommodate their needs. In middle-older adults, environmental factors and resources have been reported as the most common barriers to EX/PA participation; whereas, the belief that an activity will be beneficial, is identified among the most important motivators (Spiteri et al., 2019). In this regard, the recognition of the benefit of EX/PA for diabetes prevention and strategies to overcome barriers to EX/PA are both key components of the PreventT2 curriculum. However, middle-older women may need specific guidance regarding important Barriers in their social context, especially the family role and related commitments, which can act either as a motivator or as a barrier (Bean, Dineen, & Jung, 2020; Grundy & Henretta, 2006; Kelly et al., 2016; Korkiakangas et al., 2011; Parker & Patten, 2013; Spiteri et al., 2019).

Using a short-term (3-weeks) DPP intervention but including a 1-year follow up, Bean et al. (2020) profiled patterns of the EX/PA change process and associated barriers and strategies of women with prediabetes utilizing a qualitative approach. Their results suggest that participants profiled as *consistently inactive* (i.e., those who described low EX/PA levels before the program, had a slightly increase during the program, and were perceived to return to limited EX/PA engagement after the program) were not able to plan for and/or overcome their barriers by using key behavioral strategies to EX/PA engagement (e.g., applying learned knowledge/skills, scheduling EX/PA into day/week, self-monitoring, being self-compassionate, planning ahead) in comparison to barrier management strategies in those profiled as *increased/peak in and* *maintenance* of EX/PA levels in response to the intervention. It is worth mentioning that the majority of EX/PA barrier management evidence in the literature specific to DPP resulted from predominantly qualitative inquiry studies (Azzi et al., 2020; Bean, Dineen, & Jung, 2020; Casey et al., 2010; Korkiakangas et al., 2011; Whittemore, Rosenberg, & Sangchoon, 2013); suggesting that quantitative studies examining Barriers, and especially Benefits, are warranted.

Notably, there is an overall lack of research on social and personal factors which influence EX/PA adherence and weight loss success among middle-older women, the most common participants in the Prevent T2, warranting research on this topic in general and within this cohort specifically. Also, despite the 2016 version of the Prevent T2 curriculum emphasizing EX/PA behaviors, to date no research studies have examined the role of psychosocial factors and the effectiveness of this specific version to improve EX/PA behaviors.

CHAPTER 3

DEPRESSIVE SYMPTOMS, BUT NOT MODERATE-TO-VIGOROUS PHYSICAL ACTIVITY, IMPACTS SEXUAL WELL-BEING, AND MENOPAUSE-SPECIFIC QUALITY OF LIFE IN MIDDLE-AGED WOMEN

Running title: Depression impacts sexual well-being and MENQOL

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3.1. Abstract

Physical inactivity, unhealthy weight status, prevalence of chronic conditions, and psychosocial distress are common complaints for early menopausal women and are linked to reductions in sexual well-being and menopause-specific quality of life (MENQOL); however, the integration of these variables has not been well characterized in this cohort. OBJECTIVE: The aim of the current study was to examine the influence of objectively measured physical activity (PA) and adiposity (%Fat) on sexual well-being and MENQOL outcomes, controlling for health status (comorbidities and medications use) and psychosocial well-being (depressive symptoms and perceived stress), in middle-aged postmenopausal women. METHODS: Participants (n=68, 58.6 ± 3.4 yo, 92.6% Non-Hispanic White, 80.9% married/partnered, 51.5% overweight/obese) were assessed for moderate-to-vigorous PA (MVPA) via accelerometers, adiposity via dual-energy X-ray absorptiometry, total number of comorbidities and medications using a self-administered health history form, depressive symptoms according to the Beck Depression Inventory-II and perceived stress via the Perceived Stress Scale, and sexual well-being and MENQOL according to the Greene Climacteric Scale and the Menopause Specific Quality of Life Questionnaire (in the form of sexual, physical, psychosocial, and vasomotor domains). RESULTS: Bivariate correlations indicated that lower MVPA and higher %Fat were both associated with lower MENQOL in the physical domain (both $r = .27$, $P < .05$); however, no other associations with any other indicators of sexual well-being or MENQOL were apparent (all $P > .05$). Hierarchical regression analyses revealed that a) higher number of comorbidities, medications use, and greater depression scores significantly predicted less favorable sexual well-being, independent of MVPA and %Fat (standardized Beta coefficients range = .22-.56, all $P <$ .05), b) with the exception of the vasomotor domain, depression was the most consistent

predictor of MENQOL (models $P \leq .001$), and c) increased adiposity augmented the influence of depression on the physical domain of MENQOL (Beta = .40. $P = .002$). Future research should consider integrated study designs exploring the effect of increased PA behavior on sexual well-being through the favorable effects on adiposity, comorbidities and depressive symptoms in early menopausal women known to be afflicted with a reduction in sexual quality of life.
KEYWORDS: accelerometer-measured physical activity, sexual well-being, menopause specific quality of life, middle-aged women.

3.2. Introduction

The shape of the population pyramid is changing to a rectangle with many women coinciding with what is often identified as the midlife age category (aged 45-64 years) (Colby et al., 2015; UN, 2019b; Whiteley, DiBonaventura, Wagner, Alvir, & Shah, 2013). Midlife is a critical period in the female life course given the concomitant hormonal, physical, and psychological changes amidst numerous common challenges in the social and personal domains that collectively often compromise well-being (Grundy & Henretta, 2006; NAMS, 2020).

Sexual well-being is a core component of women's lives that a) relates to both physical and mental health domains and b) is relevant throughout the entire lifespan and not just during the reproductive years (Parish et al., 2019). Sexual affect and cognition in the form of sexual attitudes and satisfaction, sexual motivation in the form of sexual interest, and common physiological changes associated with menopause (e.g., vasomotor symptoms, vaginal dryness) have been previously used to characterize sexual well-being in middle-older women (Fraser et al., 2004; Santos-Iglesias et al., 2016). Given that menopause-associated changes may disrupt physical, emotional, and social aspects of a woman's life, menopause specific quality of life (MENQOL) should also be considered a salient construct impacting the midlife experience of sexuality and relatedly, sexual well-being (Tsai et al., 2011; Utian, 2007). Sexual well-being is compromised in females during the middle-aged period for multi-factorial reasons, including the menopausal transition (Carcelén-Fraile et al., 2020). Indeed, some conditions and risk factors that are associated with male sexual dysfunction such as aging, comorbidities, and psychological distress (e.g., depression and stress) also appear to be associated with poor sexual well-being in females (Corona et al., 2020; Markos, 2012).

Current trends confirm the existence of health disparities with middle-older female populations being more likely than men to have multiple chronic conditions (i.e., having two or more chronic diseases simultaneously) (Buttorff et al., 2017; Goodman et al., 2013). Moreover, middle-older women have a higher risk of chronic conditions such as depression, type II diabetes mellitus, and certain types of cancer (Boersma et al., 2020; Martin et al., 2010; Ohkuma et al., 2018, 2019; Robbins et al., 2015; WHO, 2007; Xiang, 2016). This is salient as there is a greater likelihood of increased symptoms of depression linked with menopausal status relative to pre-menopause, even among women without a history of depression (Mulhall et al., 2018), while several common symptoms of the perimenopause (e.g., night sweats, energy changes, decrease in libido) also co-occur and overlap with depressive symptoms and perceived stress. In fact, depression is one of the leading causes of disease-related disability in women rending them nearly twice as likely as men to suffer from an episode of depression (Sassarini, 2016). Therefore, the effect of depression and the menopause transition on sexual well-being and MENQOL may be additive (Maki et al 2019; Prairie et al 2015; Uguz et al 2011), which collectively represents a significant burden on psychosocial well-being.

Accordingly, women also use more prescription medications compared to the male population, with 33.8% of males and 38.9% of females aged 45-64 years self-reporting using three or more prescription drugs (NCHS, 2021). Additionally, the presence of gradual weight gain that intensifies at midlife aggravates the situation (Davis et al., 2012; Jaspers et al., 2015). Indeed, women have a higher incidence of overweight and obesity compared to male counterparts with the peak of prevalence among obese women being between 44 and 47 years (Wang et al., 2007), which is early midlife.

There is mounting evidence indicating that engaging in habitual exercise (EX) and physical activity (PA) may prevent or attenuate the adverse effects of obesity on women's health (Pérez-López, Martínez-Domínguez, Lajusticia, & Chedraui, 2017; USDHHS, 2018a). Thus, it is theoretically plausible that EX/PA behavior would also positively influence midlife women's sexual well-being given the recognized improvements of habitual EX/PA on adiposity, chronic disease prevention, and psychosocial well-being (Dubnov et al., 2003; Elavsky, 2006, 2009; Elavsky & McAuley, 2007; Mirzaiinjmabadi et al., 2006; Reed et al., 2014). Although positive effects of EX/PA for nonhormone management of symptoms that might impact sexual well-being and improve MENQOL in middle-life women have been reported (Ennour-Idrissi et al., 2015; Fontvieille et al., 2017; Mansikkamäki et al., 2016; Mansikkamäki et al., 2015; Mendoza et al., 2016; Reed et al., 2014), a recent systematic review on the effects of EX/PA on sexual functioning and quality of sexual life in peri- and postmenopausal women suggests that the effects of moderate-to-vigorous intensity PA (MVPA) on sexual well-being remain incompletely characterized (Carcelén-Fraile et al., 2020). Moreover, research investigating the link between MVPA or adiposity and sexual well-being utilizing objective assessment methods (e.g., accelerometer, dual energy x-ray absorptiometry), rather than self-report methods, is especially scarce.

To date, most studies have examined the associations among PA (mostly self-reported), weight status, sexual well-being, and MENQOL in midlife women in an independent fashion (Carcelén-Fraile et al., 2020; Mansikkamäki et al., 2015; Marín-Jiménez et al., 2020; Mirhaghjou et al., 2016). As multimorbidity can be difficult to manage, particularly when coupled with depression and stress (Buttorff et al., 2017), and given the numerous theoretical links among adiposity and MVPA as independent variables of interest, it is prudent to assess the predictive role of these health-related outcomes on sexual and menopausal well-being in a more integrated manner.

In this context, the primary aim of the present study was to examine the relative influence of accelerometer measured MVPA and adiposity on sexual and menopausal well-being in midlife postmenopausal women while controlling for health status (total number of comorbidities and medications) and psychosocial wellbeing (depressive symptoms and perceived stress scores). It was hypothesized that higher levels of daily MVPA and lower adiposity would be associated with more favorable sexual well-being and MENQOL. Because it was anticipated that health status and psychosocial well-being, especially depressive symptoms, would influence sexual and menopausal well-being, these variables were controlled in the analysis. In this regard, it was hypothesized that although higher scores in these covariates would inversely predict well-being, the predictive influence of both MVPA and adiposity on sexual well-being and MENQOL would remain, due to the strength of their relative contribution to the dependent variables of interest.

3.3. Methods

3.3.1. Study Design and Participants

This study is a secondary analysis of a larger cross-sectional project that primarily aimed to investigate EX/PA behaviors, physical functioning, psychosocial constructs, diet, numerous biomarkers, and body composition in middle-aged postmenopausal women. All required data collection was conducted in two visits to the laboratory 7-10 days apart to allow for objective MVPA measurement in the interim. All procedures of the parent project were approved by the university's Institutional Review Board. All participants were fully informed about the goal, procedures, and risks of the study and provided written informed consent prior to enrollment.

Sixty-eight community-dwelling postmenopausal middle-aged women were included in the current analysis. For the parent project, recruitment strategies included flyers, e-mail advertisements delivered amongst staff, faculty, and alumni organizations of a major university, and word-of-mouth. Given the characteristics of the assessments, exclusion criteria included chronic obstructive pulmonary disease including severe allergies or asthma, current use of corticosteroids, HIV, uncontrolled diabetes, current or prior mental illness or major clinical depression, severe arthritis, symptomatic joint abnormalities, symptomatic nervous system disorders, medical conditions that may affect balance, traumas requiring medical attention in the last year or any conditions which would preclude completion of physical testing such as severe limb injuries, severe neuropathy, and requiring the use of assistive devices to walk. Participants also had to be non-smoking for at least the past two years, and weight stable (within 2.6 kg) for the past three months. Self-reported medical conditions and use of prescription medications was ascertained via paper questionnaires. Web-based internet surveys were utilized to collect psychosocial data.

3.3.2. Measures

Demographics, health history, and medications usage: Demographics, health history and current medication use were assessed using a self-administered form that allows for assessment of age, current and past comorbidities (e.g., arthritis, osteoporosis, diabetes), medications (e.g., hormone replacement therapy (HRT), nonsteroidal anti-inflammatory drugs), time in menopause, among others. Participants were instructed to report all prescription and over the counter medications and supplements.

Physical activity behavior: Objective MVPA was measured via accelerometer (New Lifestyles, Inc. NL-1000, Less Summit, MO). Participants were instructed to wear an accelerometer on their non-dominant hip during all waking hours, except when participating in aquatic activities (e.g., swimming or bathing) for seven days. Quantity and intensity of PA was calculated over that 7-d period to obtain the daily average of minutes of MVPA (min•day^{-1}). Ten hours of wear time were required for a valid day, and at least four valid days were required for the participant to be included in the analysis.

Weight status and body composition: Body weight was measured to the nearest 0.1 kg using a calibrated electronic scale with participants wearing light clothing and no shoes (Tanita, Model WB-110A). Barefoot standing height was measured to the nearest 0.1 cm with a digital stadiometer (SECA 424). Body mass index (BMI, in kg·m^{-2}) was calculated using conventional methods. Adiposity, as relative whole body fat mass (%Fat), was assessed via dual-energy X-ray absorptiometry using standard software designations (iDXA General Electric Healthcare-Lunar, Madison, WI). Participants removed their shoes and any metal objects for the assessments. Scans were analyzed by two technicians for quality assurance.

Psychosocial covariates: Depression and stress, were ascertained using the Beck Depression Inventory-II (BDI), which assesses severity of depressive symptoms during the past two weeks with higher scores indicating greater depressive severity (Beck, Steer, & Brown, 1996), and the Perceived Stress Scale (PSS, ranging from 0-40), in which higher scores are indicative of greater stress (S. Cohen, Kamarck, & Memelstein, 1983).

Sexual well-being and MENQOL: Loss of sexual interest was assessed by the sexual dysfunction subscale of the Greene Climacteric Scale (Greene, 2008). Scores indicate the extent to which participants experienced loss of interest in sex in the last month in a 0-3 scale ranging from "Not at all" (0) to "Extremely" (3). Sexual, Physical, Psychosocial, and Vasomotor menopausal symptoms related to well-being were assessed using the self-administered

Menopause-Specific Quality of Life Questionnaire. The whole instrument consists of 32 items in a 0-6 Likert-scale format ranging from "Not at all" to "Extremely". Each item assesses the degree to which participants had been experiencing the problem in the past week so that higher scores mean worse MENQOL. Each value was then converted into scores ranging from 1-8 for analysis according to scoring guidelines (Hilditch et al., 2008). Domain internal consistency measured by Cronbach's alpha for this questionnaire ranged from .72 (sexual) to .88 (physical) (Lewis et al., 2005).

3.3.3. Statistical Analyses

Data were inspected for outliers, normality, and other model assumptions. Descriptive estimates (means and standard deviations) were obtained for all participant characteristics and primary outcome variables. Independent-groups t tests were conducted to determine significant differences in the primary outcome variables comparing participants based on HRT use (HRT Users vs. Non-HRT users) and marital/partnered status (Married/Partnered vs. Single/Other, the latter included those unmarried, divorced, widowed, or separated participants).

An exploratory Pearson correlation matrix was performed among the continuous variables to determine independent bivariate associations. Subsequently, hierarchical linear regression analyses were utilized to determine the independent influence of MVPA and %Fat on sexual well-being and MENQOL domains while controlling for potential confounders of health status (total number of comorbidities and medications) and psychosocial wellbeing (depressive symptoms and perceived stress scores). Variables that were significantly bivariate correlated with sexual well-being and MENQOL domains were included as independent variables in the regression models. Analyses were performed using SPSS 25.0 for Macintosh (Armonk, NY: IBM Corp). Statistical significance was set at $P < .05$ for all tests.

3.4. Results

3.4.1. Descriptive Characteristics

No transformations were required as data met assumptions of univariate normality based on skewness (< |3|) and kurtosis (< |10|) (Weston & Gore, 2006). Participant demographic characteristics and health history are presented in Table 3.1. Participants were 92.6% Non-Hispanic White and 7.4% Non-Hispanic Black with the balance Other. Married/partnered participants constituted 80.9% of the sample while 14.7% were categorized as single/other and 4.4% not responded. The majority of the participants reported having at least one comorbidity (69.1%) whereas 29.4% reported having three or more medical conditions, with arthritis (38.4%) being the most commonly reported. The sample was predominantly overweight/obese (51.5%) based on BMI criteria (CDC, 2020a).

3.4.2. Comparative Analyses for Hormone Therapy and Partnered status

Approximately 15% of the sample reported taking HRT with only two participants reporting using progestogen agents. HRT users (n = 10) were lower in BMI and %Fat compared to non-HRT users (n = 56) (22.7 ± 3.1 vs. 26.5 ± 5.0 kg·m^{-2}; 34.0 ± 4.7 vs. 39.0 ± 6.3%, respectively; both $P = .02$). No other differences on age, comorbidities and medications, depression and stress, objective MVPA, sexual well-being or MENQOL outcomes were observed based on HRT use. In addition, married/partnered women reported a greater loss of sexual interest than single/other participants (1.2 ± 1.1 vs. .27 ± .47; $P \leq .001$). No differences were seen in any other variables of interest based on marital/partnered status.

3.4.3. Correlations Among the Independent and Dependent Variables of Interest

As presented in Table 3.2, bivariate associations were observed between MVPA and health indicators, psychosocial variables, and MENQOL. For example, a greater number of comorbidities and medications were significantly (all $P < .05$) and directly correlated with higher depression (r = .39 and .25, respectively) and perceived stress scores (r = .40 and .31), loss of sexual interest (r = .43 and .30), and poorer scores in most MENQOL domains (r range = .35-.53), except the vasomotor domain. Higher depressive symptoms were associated with higher vasomotor domain scores (r = .29, all $P < .05$). An increased %Fat was associated with lower levels of MVPA (r = -.47, $P \leq .001$) and poorer scores in the physical domain of the MENQOL (r = .27, $P = .01$). Higher MVPA was correlated with less bothersome symptoms in the physical domain of the MENQOL (r = -.27, $P = .03$), but it was not associated with any other indicators of sexual well-being or MENQOL. Poorer physical domain scores were also directly associated with key psychosocial constructs including depression, perceived stress, loss of sexual interest, and the sexual domain of MENQOL, all denoted by positive associations (see Table 3.2).

3.4.4. Predictors of Sexual Well-being and MENQOL

A summary of the results for the hierarchical linear regression analyses predicting sexual well-being (models A and B) and the physical domain of the MENQOL (model C) is presented in Tables 3.3-.4 and 3.5, respectively. Significant predictive models were found by testing the relative importance of objectively measured daily minutes of MVPA and %Fat separately when controlling for the key theoretically associated covariates, total number of comorbidities and medications, and depressive symptoms and perceived stress scores.

Overall, higher number of comorbidities and medications and higher depression scores were independent predictors of lower sexual well-being by explaining a significant portion of the variance in loss of sexual interest as well as the sexual MENQOL domain in a positive/direct linear fashion. Further, comorbidities played a significant role in predicting loss of sexual interest (P = .001, Table 3.3) whereas depression scores remained as a significant independent predictor of the sexual MENQOL domain (P < .001, Table 3.4) after accounting for key health-related and modifiable outcomes such as objective MVPA and %Fat. For example, for every unit of increase in the depression score participants experienced an average increase of .56 units in sexual MENQOL symptoms. Objective MVPA played no role in predicting loss of sexual interest or sexual MENQOL. Similarly, perceived stress was not a significant covariate in these models either.

As can be seen in Table 3.5, a higher number of comorbidities and greater depression scores were also independent and direct predictors of a poorer physical MENQOL domain (Beta = .29 and .33, respectively, both P < .001). The influence of depression on the physical domain increased when %Fat was included as a significant predictor in the model (step C.2.2), but not when including MVPA (step C.2.1), overall indicating that greater depression scores and %Fat are collectively associated with more bothersome physical menopausal symptoms.

Depression scores were identified as the most consistent predictor of the sexual and physical MENQOL domains, while medications, perceived stress, and MVPA played no role collectively (all P > .005 for the respective Beta coefficients). Number of medications, depression, and perceived stress scores were consistently independent predictors of poorer psychosocial MENQOL domain in all the models tested (all P < .05 for the respective Beta coefficients, R^2 range = .69-.74, data not shown). No significant predictors of the vasomotor MENQOL domain were found (all P >.05, data not shown).

3.5. Discussion

The present study examined the predictive contribution of MVPA and adiposity of sexual well-being and MENQOL domains controlling for health status (total number of comorbidities, medications) and psychosocial well-being (depressive symptoms, perceived stress), in a community sample of middle-older early postmenopausal women. The examination of potential differences based on HRT use and partnered status was also conducted. To our knowledge, the influence of objectively-measured daily MVPA and adiposity, while controlling for these potential health status and psychosocial covariates on women's sexual and menopausal well-being has not been previously evaluated in such an integrated manner.

Our results are confirmatory regarding the significant bivariate relationships between MVPA and adiposity, whereas the associations between these key variables and menopausal well-being were less convincing. In the current study, we examined potential health status and psychosocial contributors to sexual and menopausal well-being that were hypothesized as confounders. However, our primary hypothesis that MVPA and adiposity would be major predictors of sexual well-being and several aspects of MENQOL was not confirmed by our data. Nonetheless, our findings are of interest and novel in a growing sector of our population: a) higher total number of comorbidities and medications and/or depression scores significantly predicted several domains of MENQOL including sexual, physical, and psychosocial aspects, independent of the key behavioral factors of interest, MVPA and adiposity, b) depressive symptoms were the most consistent predictor of the sexual, physical, and psychosocial MENQOL domains, and c) adiposity augments the influence of depression on the physical MENQOL domain.

Having a stable sexual partner has been reported as a relevant factor associated with having sexual problems (Cuerva et al., 2018; Hooghe, 2012). Although partnered status was assessed in this study, inferred as an indicator of sexual partnership stability, the only difference we observed was indeed regarding loss of sexual interest with partnered women reporting a greater loss compared to single participants. No other differences were apparent in the main outcomes of interest based on marital/partnered classification besides loss of sexual interest. This can be due to the restrictive nature of the age range of our sample (50-64 yo) as it has been reported that the positive impact of having a partner on subjective and sexual well-being significantly increases with age (Hooghe, 2012).

The multimorbid state observed in our sample is similar to the prevalence of chronic conditions previously reported (Boersma et al., 2020; Buttorff et al., 2017). Although it has been established that chronic conditions play a critical role in engaging in PA (Sarafraz, Bagheri, Abbaszadeh, & Kafaie, 2009), no associations between MVPA and comorbidities and medications were confirmed by our data. It is important to note that unlike other studies based on self-reporting, our MVPA evidence is based on accelerometer-measured data.

The positive relationships between number of comorbidities, medications, depression, and stress was expected as chronic conditions often disrupts women's daily functioning, ability to engage in social activities, mood and feelings, and can ultimately lead to psychosocial distress, especially in later life (Clarke & Bennett, 2013). Notably, it is not just the chronic disease or condition that can hamper women's psychosocial well-being; often, the medications used for treatment can have negative implications as well. For example, blood pressure medications often cause fatigue, while sexual dysfunction is an important under-estimated side effect of antidepressant drugs (Chiesa et al., 2009; Parish et al., 2019). Accordingly, some evidence also suggests that the complex interrelationship between women's chronic conditions/medications and depressive symptoms has yet to be determined to better understand if having chronic conditions increases the prevalence of depression or whether depressive symptoms increase the risk of having a chronic condition, and how such dynamic overlaps with/relates to health behaviors and well-being (CDC, 2012; NIMH, 2021; Xu et al., 2019).

The literature is divergent or inconclusive regarding the role of PA behavior and adiposity on women's sexual and menopausal well-being at midlife. Increased weight status might adversely affect sexual function (Davis et al., 2012), probably due to a "domino" effect on overall health and other menopausal symptoms (Gartoulla et al., 2018; Genazzani et al., 2007). For example, Pace et al. (2009) found that a BMI greater than 30 $kg \cdot m^{-2}$ was inversely associated with sexual well-being as indicated by sexual satisfaction, arousal, orgasm, and lubrication, whereas sexual desire and pain were not correlated (Pace, Silvestri, Gualá, & Vicentini, 2009). Moreover, in a female overweight and diabetic population it has been elucidated that sexual dysfunctions (e.g., loss of sexual interest, decrease in lubrication) are more strongly related to psychological factors and depressed mood than to metabolic alterations per se (Kizilay et al., 2017). Further, evidence establishes that poor health and low mental health scores are significantly associated with more sexual dysfunction (Addis et al., 2006; Sánchez-Zarza et al., 2020) and these are considerable factors affecting the quality of life among middle-aged women (Uguz et al., 2011). Thus, it has been suggested that depressive symptoms may overshadow the hormonal contribution to sexual well-being and sexual function in this cohort (Avis et al., 2009).

Some studies have reported favorable associations among PA behavior, sexual well-being, and MENQOL symptoms via their well-known structural and functional dose-response cardiometabolic adaptations and weight control in middle-aged women (Mendoza et al., 2016;

Miner et al., 2012; USDHHS, 2018a). Recent evidence utilizing accelerometry proposes that greater PA, especially of vigorous intensity, is associated with better health-related quality of life, particularly in the physical domain (Koolhaas et al., 2018; Marín-Jiménez et al., 2020). Koolhaas et al. (2018) aggregate that specific activity types such as sports and cycling contributed more to health-related quality of life compared to walking and domestic work. Elavsky (2006) reported that mood appears to play a role in the PA-MENQOL relationship in previously low-active, symptomatic middle-aged women. Thus, although no direct associations between either MVPA or adiposity and sexual well-being were found in our sample, we confirmed that depressive symptoms are relevant factors in the dynamic (Blümel et al 2015). Further, our results suggest that adiposity augments the influence of depressive symptoms on MENQOL indicated by physical symptoms such as aching in muscles and joints as well as a decrease in physical strength and stamina. As menopause symptoms complicate, co-occur, and overlap with the presentation of depression (Maki et al., 2019; Worsley, Bell, Kulkarni, & Davis, 2014), it is speculated that the influence of such symptoms on the sexual, physical, and psychosocial MENQOL domains of our sample might have concealed the influence of MVPA and adiposity.

A vast majority of the menopausal well-being literature has particularly focused on PA (Bachmann, 2015; A. Daley et al., 2014; A. J. Daley et al., 2015; Shepherd-Banigan et al., 2017; Sternfeld & Dugan, 2011) or weight status (Huang et al., 2010) and vasomotor symptoms. In brief, it has been theorized that because EX/PA raises body temperature it could increase the occurrence of vasomotor symptoms (Mansikkamäki et al., 2015; Thurston et al., 2012). Alternatively, PA improves thermoregulation by inducing central ß-endorphin production/releasing through activation of large muscle groups during menopause (when the production of estrogen is drastically reduced) (Berin et al., 2019; Lindh-Åstrand et al., 2004). In our sample, MENQOL vasomotor symptoms were not associated with PA or adiposity which, rather than contradicting the existing evidence, confirms that the association between PA and vasomotor symptoms remains inconclusive (A. Daley et al., 2014; A. J. Daley et al., 2015; McGarry, Geary, & Gopinath, 2018; Mendoza et al., 2016; Ziv-Gal & Flaws, 2010). Elavsky et al. (2012) confirmed that individual psychosocial characteristics including depressive symptoms and anxiety differentiate between middle-aged women for whom engaging in more PA is associated with experiencing fewer vasomotor symptoms as compared to those for whom more PA is linked to more symptoms. The authors observed that women with positive association between moderate intensity PA and hot flash frequency reported fewer depressive symptoms as compared to participants who showed a negative association. This partially aligns with our findings as a significant role of depressive symptoms in sexual and most MENQOL domains was observed whereas a positive bivariate correlation was found between the vasomotor MENQOL domain and depressive symptoms; however, MVPA was not independently associated with any of these outcomes in our sample.

The positive effect of EX/PA on depression is well established (Gianfredi et al., 2020; Pérez-López et al., 2017), especially among individuals with chronic conditions (Herring et al 2012). It is speculated that the potential positive influence of MVPA on sexual and menopausal well-being may have been obscured in our sample by the depression symptoms, due to its strength. Thus, our data support our original impetus for our aim and hypothesis that a more integrated research is needed to determine if engagement in PA, of sufficient intensity, duration, and frequency, could improve depression symptoms and subsequently enhance sexual well-being and MENQOL. Notably, the therapeutic implications of PA as a stand-alone treatment for depressive symptoms or as an adjunct to antidepressant medications to enhance effectiveness is endorsed (Kvam, Kleppe, Nordhus, & Hovland, 2016; Mura, Moro, Patten, & Carta, 2014; Netz, 2017).

The current study is not without its limitations. First, the secondary data analysis nature of the study limited the possibility to obtain additional information relevant to the primary research question (e.g., frequency and severity of MENQOL symptoms, attitudes and beliefs toward sexuality during menopause), thus limiting the analysis/interpretation to the data available. For example, a possible related variable that was not explored in the parent study was the proportion of participants who were indeed sexually active (regardless of partner status) and the corresponding frequency of sexual activity, which seems to be associated with not only sexual well-being and satisfaction but with weight status (Addis et al., 2006). Second, the cross-sectional design of the study as well as the analyses do not allow for causal conclusions regarding the interrelationships among the variables. Third, our sample was physically/cognitively functional and predominantly Non-Hispanic white, which may limit generalizability of the findings to a less functional and more racially/ethnically diverse population. This becomes salient because health behaviors and the menopausal and sexual experience vary across racial/ethnic groups and sociocultural backgrounds.

Weaknesses are balanced with several identified strengths. First, we utilized an objective assessment method of the independent variables MVPA and adiposity which were lacking in the literature exploring sexual well-being and MENQOL. Second, we were able to assess the predictive influence of PA behavior and weight status accounting for key health status and psychosocial constructs on sexual and menopausal well-being in an integrated manner. Third, a great majority of the chronic conditions identified by the U.S. Department of Health and Human

Services were assessed and coded for our analysis which contributes qualitatively and quantitatively to the body of knowledge to inform research, policy, program, and practice (Goodman et al., 2013).

Irrespective of our results and the identified strengths and weaknesses of our study, the area of sexual well-being and MENQOL in middle-aged women remains an important topic of research, clinical and public health interest. Future studies should characterize severity and frequency of menopausal symptoms that influence sexual well-being and MENQOL domains (Reed et al., 2014) accounting for partnered status as well as sexual activity and satisfaction across the weight status spectrum and women with different levels of PA. Also, given that physical inactivity, rather than EX/PA behavior alone, has proved to be an independent risk factor for physical and mental health conditions among the middle-aged female population (Lee et al., 2012; Marín-Jiménez et al., 2020), future studies should seek to understand the role of objectively measured sedentary behavior in sexual and menopausal well-being. Similarly, more vigorous-intensity PA and strength/resistance training have proven to be associated with better health outcomes (Battista et al., 2021; USDHHS, 2018a), while shorter but more intense sessions are recommended for middle-aged individuals due to feasibility and practicality (Evans & Castillo-Hernández, 2020). Thus, research exploring the influence of higher intensity PA behaviors on sexual well-being and MENQOL, which might mean a reduction in exercise time with similar improvements for women's health (Marín-Jiménez et al., 2020) is warranted. Finally, evidence suggests depressed mood, sleep, and sexual well-being co-vary in middle-aged postmenopausal women. Therefore, further research examining this phenomenon as a symptom triad potentially distinct from clinical depression at midlife is recommended (Prairie et al., 2015). Notably, the 24-hr activity cycle paradigm that accounts for the inter-relatedness of sleep, sedentary, and PA behaviors may be applicable to sexual well-being and MENQOL in middle-aged women (Rosenberger et al., 2019). Collectively, this will inform the implementation of tailored prospective/interventional studies on the topic of modifiable health behaviors and women's health (Aparicio, Flor-Alemany, Marín-Jiménez, Coll-Risco, & Aranda, 2021).

Conclusions

Findings from the current study underscore that health status, as assessed by number of comorbidities and medications, and depressive symptoms negatively impact sexual and menopausal well-being in middle-older early menopausal women. Alternatively, MVPA does not appear to play a significant independent role in explaining sexual well-being beyond health status or depression scores. Beyond the myriad well-established benefits of habitual MVPA for physical and psychosocial health (USDHHS, 2018a), the potential positive implications of PA and/or EX on sexual well-being and MENQOL may be in fact indirect, which will both prove more challenging to measure and require a more integrated study design. For example, highly active middle-older women are leaner, present with less chronic conditions (and thus medications), experience less depression, and have more favorable sleep profiles. Thus, enhanced sexual well-being and MENQOL may be the result of numerous health outcomes or the interaction thereof. Given the growing number of women in this cohort based on societal aging demographics and the rising rates of 1) chronic conditions and medications, 2) physical inactivity, 3) obesity, and 4) depression, additional integrated research is warranted regarding the utility of PA and/or weight management to enhance sexual and menopausal well-being in early menopausal women.

Table 3.1

Demographic characteristics, health history, physical activity, psychosocial covariates, and descriptive estimates of the dependent psychosocial measures of the participants (n = 68).

Characteristic	(M ± SD)	Range
Age (years)	58.6 ± 3.4	50-64
Time in menopause (months)	111.2 ± 87.2	8-420
Number of comorbidities (total)	1.9 ± 1.8	0-9
Number of medications (total)	3.2 ± 3.1	0-16
BDI	7.2 ± 6.6	0-30
PSS	11.3 ± 7.1	0-30
MVPA ($min \cdot day^{-1}$)	29.4 ± 21.0	2.3-94.6
%Fat	38.5 ± 6.7	25.3-52.8
BMI ($kg \cdot m^{-2}$)	26.0 ± 5.1	17.4-38.3
Dependent constructs		
GCS Loss of sexual interest	1.13 ± 1.13	0-3
Sexual MENQOL	2.64 ± 1.79	1.00-8.00
Physical MENQOL	2.30 ± 1.02	1.00-4.89
Psychosocial MENQOL	2.46 ± 1.40	1.00-6.57
Vasomotor MENQOL	2.00 ± 1.57	1.00-7.67

Notes: M = Mean; SD = Standard deviation; BDI = Beck Depression Inventory-II; PSS = Perceived Stress Scale; BMI = Body mass index; %Fat = Adiposity percentage; MVPA = Moderate-to-Vigorous Intensity Physical Activity; GCS = Greene Climacteric Scale; MENQOL = Menopause Specific Quality of Life Scale.

Table 3.2

Pearson correlations among health status, psychosocial well-being, physical activity, adiposity, sexual well-being, and menopausal quality of life (n = 68).

	1	2	3	4	5	6	7	8	9	10
1. Number of comorbidities (total)	--									
2. Number of medications (total)	**.47 [a]**	--								
3. BDI	**.39 [a]**	**.25 [b]**	--							
4. PSS	**.40 [a]**	**.31 [b]**	**.69 [a]**	--						
5. MVPA	-.09	-.23	-.08	-.16	--					
6. %Fat	.23	**.27 [b]**	-.02	.08	**-.47 [a]**	--				
GCS										
7. Loss of sexual interest	**.43 [a]**	**.30 [b]**	**.42 [a]**	**.34 [a]**	-.20	-.02	--			
MENQOL domains										
8. Sexual	**.35 [b]**	**.38 [b]**	**.68 [a]**	**.53 [a]**	-.17	.02	**.60 [a]**	--		
9. Physical	**.53 [a]**	**.40 [a]**	**.61 [a]**	**.59 [a]**	**-.27 [b]**	**.27 [b]**	**.40 [a]**	**.48 [a]**	--	
10. Psychosocial	**.36 [b]**	**.44 [a]**	**.76 [a]**	**.74 [a]**	-.22	.11	**.50 [a]**	**.71 [a]**	-.04	--
11. Vasomotor	.11	-.06	**.29 [b]**	.18	-.02	-.08	.09	.13	**.43 [a]**	.18

Notes: Values denote r coefficients; ^{a} = $P \leq 0.001$; ^{b} = $P < 0.05$; BDI = Beck Depression Inventory-II score; PSS = Perceived Stress Scale score; MVPA = Moderate-to-Vigorous Intensity Physical Activity in min·day^{-1}; %Fat = Adiposity percentage; GCS = Greene Climacteric Scale; MENQOL = Menopause Specific Quality of Life Scale.

Table 3.3

Hierarchical linear regression analyses for health status, psychosocial, physical activity, and adiposity factors predicting loss of sexual interest (Model A).

Steps	Predictors	R^2	P^a	ß	Beta	P^b
A.1	Comorbidities +	.201	.001	.233	.394	.004
	Medications			.037	.102	.436
A.2	Comorbidities +	.272	.001	.174	.293	.033
	Medications +			.033	.090	.485
	BDI +			.035	.207	.208
	PSS			.016	.100	.545
A.2.1	Comorbidities +	.278	.003	.173	.292	.034
	Medications +			.026	.071	.591
	BDI +			.037	.218	.190
	SS +			.012	.075	.659
	MVPA			-.005	-.083	.502
A.2.2	Comorbidities +	.283	.001	.170	.285	.039
	Medications +			.044	.123	.347
	BDI +			.036	.221	.189
	PSS +			.012	.075	.653
	%FAT			-.017	-.103	.383

Notes: ß denotes unstandardized regression coefficients while Beta denotes standardized coefficients; [a] = Model significance, [b] = Beta significance.

Confounders block 1: Comorbidities = Total number of comorbidities and Medications = Total number of medications.

Confounders block 2: BDI = Beck Depression Inventory-II and PSS = Perceived Stress Scale scores.

Predictive variables block 3 entered separately: MVPA = Moderate-to-Vigorous Intensity Physical Activity in min•day^{-1} or %Fat = Adiposity percentage.

Table 3.4

Hierarchical linear regression analyses for health status, psychosocial, physical activity, and adiposity factors predicting the sexual MENQOL domain (Model B).

Steps	Predictors	R^2	P^a	ß	Beta	P^b
B.1	Comorbidities +	.171	**.004**	.238	.249	.064
	Medications			.142	.239	.075
B.2	Comorbidities +	.512	<.001	.021	.022	.840
	Medications +			**.135**	**.227**	**.034**
	BDI +			**.156**	**.559**	**<.001**
	PSS			.023	.094	.480
B.2.1	Comorbidities +	**.515**	<.001	.023	.025	.825
	Medications +			.127	.214	.050
	BDI +			**.156**	**.559**	**<.001**
	PSS +			.022	.088	.510
	MVPA			-.005	-.059	.540
B.2.2	Comorbidities +	**.510**	<.001	.006	.006	.959
	Medications +			**.126**	**.216**	**.048**
	BDI +			**.150**	**.558**	**<.001**
	PSS +			.021	.087	.524
	%FAT			-.007	-.027	.781

Notes: ** $P < 0.05$; ß denotes unstandardized regression coefficients while Beta denotes standardized coefficients; [a] = Model significance, [b] = Beta significance.

Confounders block 1: Comorbidities = Total number of comorbidities and Medications = Total number of medications.

Confounders block 2: BDI = Beck Depression Inventory-II and PSS = Perceived Stress Scale scores.

Predictive variables block 3 entered separately: MVPA = Moderate-to-Vigorous Intensity Physical Activity in min•day^{-1} or %Fat = Adiposity percentage.

Table 3.5

Hierarchical linear regression analyses for health status, psychosocial, physical activity, and adiposity factors predicting the physical MENQOL domain (Model C).

Steps	Predictors	R^2	P^a	ß	Beta	P^b
C.1	**Comorbidities +**	.299	<.001	**.252**	**.474**	**<.001**
	Medications			.045	.135	.269
C.2	**Comorbidities +**	.518	<.001	**.153**	**.288**	**.010**
	Medications +			.036	.108	.301
	BDI +			**.050**	**.325**	**.015**
	PSS			.031	.226	.091
C.2.1	**Comorbidities +**	.537	<.001	**.156**	**.294**	**.008**
	Medications +			.025	.076	.470
	BDI +			**.050**	**.326**	**.014**
	PSS +			.029	.212	.109
	MVPA			-.007	-.145	.128
C.2.2	Comorbidities +	.581	<.001	.115	.202	.055
	Medications +			.033	.095	.342
	BDI +			**.064**	**.405**	**.002**
	PSS +			.030	.209	.100
	%FAT			**.029**	**.180**	**.048**

Notes: ** $P < 0.05$; ß denotes unstandardized regression coefficients while Beta denotes standardized coefficients; [a] = Model significance, [b] = Beta significance.

Confounders block 1: Comorbidities = Total number of comorbidities and Medications = Total number of medications.

Confounders block 2: BDI = Beck Depression Inventory-II and PSS = Perceived Stress Scale scores.

Predictive variables block 3 entered separately: MVPA = Moderate-to-Vigorous Intensity Physical Activity in min•day^{-1} or %Fat = Adiposity percentage.

CHAPTER 4

SOCIAL SUPPORT, EXERCISE BENEFITS AND BARRIERS, AND PHYSICAL ACTIVITY BEHAVIOR CHANGE IN RESPONSE TO THE DIABETES PREVENTION PROGRAM IN MIDDLE-OLDER WOMEN

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4.1. Abstract

The CDC-recognized Diabetes Prevention Program (DPP) is promising to prevent the onset of type II diabetes mellitus (T2DM) in high-risk participants by invoking a small amount of weight loss and increases in habitual exercise (EX) and physical activity (PA). However, the effectiveness of the DPP to promote EX/PA behavior change and supports and barriers to EX/PA in middle-older women, known to be at higher risk than their male counterparts, has not been well-characterized. OBJECTIVE: The aim of the present study was to determine the influence of social support (SS) and EX/PA benefits and barriers on improvements in EX/PA behaviors and whether these improvements were linked to weight loss success in response to a one-year DPP in middle-older women. METHODS: This sub-study was part of an implementation trial of a translation of the DPP Prevent T2 curriculum delivered through Cooperative Extension Services (CES). The current analytical sample was delineated to middle-aged and older women (n = 29, 60.4 ± 10.6 yo, Body Mass Index (BMI) = 35.9 ± 6.7, 75.9% Non-Hispanic White). Participants were assessed for weight status, self-reported EX/PA behavior, SS, and perceived benefits and barriers at baseline and at 12-months using validated and reliable measures. RESULTS: Repeated measures t-tests and Pearson bivariate correlational analyses indicated that a) participants experienced significant and clinically meaningful weight loss (6.3%), with those attending more program sessions experiencing greater weight loss success ($r = -.46$, $P < .05$); b) moderate and moderate-to-vigorous intensity PA increased in response to the intervention, albeit effect sizes were small and insignificant ($P > .05$); c) participant perceptions of increased SS from family participation and fewer barriers were both associated with increased vigorous intensity PA ($r = .52$ and .-.39, respectively, both $P < .05$); d) participants perceived the degree to which EX/PA 1) enhances physical performance and 2) reduces risk of disease were the highest benefits, whereas the exertion for EX/PA behaviors was consistently the greatest barrier ($P < .05$). This study adds to the limited evidence on social and personal/cognitive determinants of EX/PA behavior change in the context of DPP implementation in a growing sector of our population at high risk for developing T2DM. Future research should consider strategies to increase SS and reduce barriers to EX/PA to enhance translational DPP effectiveness in middle-older women.

KEYWORDS: social support, exercise benefits and barriers, Diabetes Prevention Program, middle-older women, weight-loss.

4.2. Introduction

Overweight/obesity along with poor health behaviors, especially poor diet quality and physical inactivity, are major threats to public health due to their contribution to numerous chronic diseases including type II diabetes mellitus (T2DM) (Hruby & Hu, 2015; Mobbs & Hof, 2010). Current trends confirm the existence of health disparities as women have a higher incidence of overweight and obesity compared to male counterparts, with the peak of prevalence among obese women being between 44 and 47 years of age (Wang et al., 2007). Notably, also compared to males, females are at greater risk of develop T2DM with advancing age (USDHHS, 2011), and subsequently greater risk for disabling and life-threatening chronic diseases associated with T2DM including cancer (Ohkuma et al., 2018, 2019), dementia (Chatterjee et al., 2016), stroke (Peters et al., 2014a), and coronary heart disease (Peters et al., 2014b).

It is well established that exercise (EX) and physical activity (PA) are effective strategies for weight management and the prevention of T2DM for middle-older women (ACSM/ADA, 2010; ADA, 2020; Anton et al., 2013; Glechner et al., 2018). This is especially salient among those who are diagnosed with prediabetes as they are more likely to develop T2DM, with about 5-10% progressing to T2DM each year (Tabák et al., 2012). Although it is well established that investment in EX/PA behaviors at midlife can optimize women's health during this stage and into later years, the average middle-older woman does not habitually engage in adequate EX/PA (Bennie et al., 2019; Du et al., 2019; El Hajj et al., 2020). Contemporary data suggest that ~80% of middle-older women in the U.S. fail to meet the guidelines for both aerobic and muscle strengthening activities (USDHHS, 2018b), thus comprising one of the cohorts with the lowest proportion meeting the guidelines (Bennie et al., 2019). Indeed, it is not only that middle-older women are insufficiently active but that they also fail to engage in intense physical activities, with only ~18% meeting the vigorous intensity plus muscle strengthening PAG through the leisure, household, and outdoor PA domains (Schaal et al., 2016), overall keeping them from experiencing the benefits of being more physically active, especially toward the specific end of preventing T2DM.

The utility of EX/PA to prevent T2DM is well endorsed by the American College of Sports Medicine and the American Diabetes Association's whereby their joint position statement indicates that structured interventions that target lifestyle modification that fosters habitual EX/PA and modest weight loss, are warranted as they a) enable sustained behavior change, and b) significantly lower T2DM risk (ADA/ACSM, 2010). Notably, the latter effect is reported to be greater than the impact of pharmacotherapy (e.g., Metformin) (Knowler et al., 2002; Knowler et al., 2009; Look et al., 2013). Moreover, evidence-based initiatives targeting lifestyle change including the CDC-recognized Diabetes Prevention Program (DPP) are timely and are promising to prevent the onset of T2DM in high-risk participants (Cefalu et al., 2016; Knowler et al., 2009). Indeed, it is possible that the same proportion of 5-10% of persons at a prediabetic stage can recede back to normoglycemia (Tabák et al., 2012). Thus, a specific curriculum addressing key lifestyle factors including EX/PA and healthy eating that is enabled through increased social support, self-efficacy, and self-monitoring, was created as a national effort to address the increasing burden of prediabetes and T2DM in the US. Although created in 2010, the most recent version, Prevent T2, has an increased focus on EX/PA compared to previous versions. Specifically, the current curriculum promotes modest weight loss (5-7%) and increased EX/PA through a 12-month, two-phase lifestyle change program (CDC, 2020b).

The Prevent T2 curriculum is grounded in Social Cognitive Theory and aims to help participants enhance overall social support, create strategies to improve their knowledge about benefits, and overcome perceived barriers. In order to maximize effectiveness, factors explaining adherence variability in response to lifestyle change interventions remains of high research interest (Nigg, 2014; Shawley-Brzoska, 2019; Shawley-Brzoska & Misra, 2018), especially with regard to both adoption and maintenance of EX/PA behaviors (Buckworth et al., 2013). In this regard, it is recognized that numerous social and personal influences may impact individuals' decisions regarding initiation or maintenance of EX/PA behavior (Nigg, 2014). According to Kappor et al. (2017), in addition to counseling regarding lifestyle change, it is important to address the unique barriers to adoption of healthy lifestyle indicators in middle-older women. Here, social support (SS) for EX/PA as well as perceived benefits from and barriers to EX/PA (Benefits and Barriers) have been shown to be relevant intervention targets to explore at the individual level to inform what may impact lifestyle change endeavors for EX/PA and weight management (Buckworth, 2018; Shawley-Brzoska, 2019; Shawley-Brzoska & Misra, 2018). Regarding SS specifically, which is considered a central factor for initial and sustained EX/PA behavior change, perceived SS can originate from different sources, such as family and friends (Nigg, 2014). For example, in individuals with T2DM, those with higher SS scores have a 17% greater chance of avoiding physical inactivity (Morowatisharifabad et al., 2019).

In middle-older adults, environmental factors and resources have been identified as the most commonly reported barriers to EX/PA participation whereas goal-setting, SS, and the belief that an activity will be beneficial are identified as the most important motivators, especially among middle-aged participants (Spiteri et al., 2019), all being key components of the PreventT2 curriculum. Understanding and addressing perceived SS and Benefits and Barriers are central to efforts to enhance DPP effectiveness, broadly defined, and remains a core area of interest especially for the Prevent T2 program which is highly focused on EX/PA for effectiveness.

Notably, there is a lack of research on factors which influence EX/PA adherence and weight loss success among middle-older women, the most common participants in the Prevent T2, warranting research on this topic in general and within this cohort specifically. Also, despite the latest version of the Prevent T2 curriculum emphasizing EX/PA behaviors, studies examining the role of psychosocial factors and the effectiveness of this specific version on improving EX/PA behaviors remain scarce (Ritchie, Carroll, Holtrop, & Havranek, 2018).

Thus, the aim of the present study was to determine the influence of perceived SS and Benefits and Barriers on improvements in EX/PA behaviors and whether these improvements were linked to change in weight in response to a one-year Cooperative Extension Services (CES) delivered DPP in middle-older women. It was hypothesized that those women who perceived greater Benefits and SS and fewer Barriers would experience greater increases in EX/PA behavior in response to the intervention. Subsequently, it was hypothesized that greater improvements in EX/PA behavior would lead to greater weight loss success in response to the program.

4.3. Methods

4.3.1. Study Design

The current study was part of a larger effectiveness-implementation trial that primarily aimed to determine the effectiveness of the DPP Prevent T2 with a social media (Facebook) enhancement, implemented with fidelity in the context of UGA Cooperative Extension, on weight status, diet quality, EX/PA, physical function, and health-related quality of life in overweight and obese individuals at a higher risk for T2DM. Specifically, the current study incorporated measures of SS and Benefits and Barriers.

4.3.2. Participants

The current study was delineated to middle-aged and older women. Thus, a subsample of twenty-nine community-dwelling middle-aged and older women (41-75 yo) were included in the current analysis. Inclusion criteria in the parent study included a clinical diagnosis of prediabetes or being at high risk for developing prediabetes or T2DM and being overweight (BMI $\geq$ 25 kg·m^{-2}) or obese (BMI $\geq$ 30 kg·m^{-2}). Prediabetes or T2DM risk status was determined using the CDC risk tests, respectively, via paper questionnaires (CDC, 2018). The Physical Activity Readiness Questionnaire (PARQ) was also utilized to determine safety for engagement in PA. For those who were eligible for both the program and research but indicated a potential concern on their PARQ, a member of the research team contacted these participants by phone to determine safety of participating in PA over the course of the program. Although CDC does not establish an upper age limit on DPP participation, exclusion criteria included individuals > 75 yo, those who were pregnant or with self-reported current diagnoses of diabetes, chronic kidney disease, liver disease, cancer, Alzheimer's or other dementias, or severe physical or cognitive limitations. Participants were recruited by CES agents and the researchers in their respective counties through physician referrals, existing community collaborations/relationships, local employers, flyers, radio announcements, newspaper, and social media advertisements. An informational session was conducted by CES agents for those who expressed interest in the DPP program to explain the option to participate in the research study. Self-reported demographic information, health history, EX/PA behavior, and perceived SS and Benefits and Barriers outcomes were ascertained utilizing web-based internet surveys (Qualtrics XM Platform™, Provo, UT). All procedures of the parent project were approved by the university's Institutional Review Board.

All participants were fully informed about the goal, procedures, and risks of the study and provided written informed consent prior to enrollment.

4.3.3. Intervention / Program Implementation

The study was delivered in 13 Georgia counties (7 metropolitan and 6 nonmetropolitan, Table 4.1) by CES agents trained as lifestyle coaches by the Diabetes Training and Technical Assistance Center (DTTAC) according to CDC standards. Program implementation began in-person between January-March 2020 and concluded between January-March 2021.

Each session of the program lasted approximately 1-hour and participants interacted with each other and with the trained lifestyle coach to discuss and problem-solve lifestyle behaviors related to nutrition and EX/PA for weight loss and decreased T2DM risk, using the Prevent T2 curriculum as a discussion guide (CDC, 2020b). The Prevent T2 curriculum is a 1-year, two-phase program. Phase I, referred to as the core phase, includes a minimum of 16 consecutive sessions meeting once a week, followed by one session every two weeks for ~ 2 months, targeting different lifestyle modification topics. Phase II, referred to as the core maintenance phase, includes a minimum of 6 monthly meetings for the last 6 months. The duration of the study (i.e., a total of 13 months) matched the length of the program being implemented, with an additional 1-month allocated for data collection and interviews following program completion. The program was converted from in-person to distance education delivery after the second week of March 2020 due to the onset of the COVID-19 pandemic. For this transition, lifestyle coaches continued to deliver the Prevent T2 curriculum as scheduled and followed CDC and Diabetes Prevention Recognition Program (DPRP) standards for virtual facilitation of National DPP sessions to ensure program fidelity (CDC, 2018, 2021). Attendance and program completion (range of maximum total possible sessions: 25-27) were tracked throughout the study.

Participants were considered per-protocol if they met CDC attendance requirements which included a) having attended at least nine sessions during the core phase and at least three sessions during the core maintenance phase, and b) had at least 9 months between first and last sessions during the 1-yr program.

4.3.4. Measures

Demographics and health history: Demographics and current and past health history were assessed at baseline using a self-administered online form that allowed for assessment of age, ethnicity, education level, and comorbidities (e.g., prior history of gestational diabetes, hypertension, etc.). For example, participants were instructed to report whether they had been told by a doctor or health care provider that they had pre-diabetes, elevated blood sugar, or borderline diabetes.

Weight status: Body weight was measured to the nearest 0.1 kg without participants wearing shoes at Baseline and at each session by CES lifestyle coaches using calibrated research-grade electronic scales (SECA, Model 876) until the switch to distance learning. Following the onset of the pandemic, participants self-reported weight using a home scale of their choice or digital scale provided by the research team (Etekcity Model EB4074C, EB9388H, EB9380H or EB4473C). Participants were instructed to take note of the clothes they wore for baseline assessments so they could wear something similar during post-intervention assessments.

Weight loss success was calculated by computing Post-test minus Baseline weight so that a negative change (ΔBody weight) or a negative percent weight change means that the participant lost weight in response to the intervention. Barefoot standing height was measured at baseline to the nearest 0.1 cm with portable stadiometers (SECA, Model 213). Body mass index was calculated using conventional methods.

Physical activity behavior: Self-reported EX/PA was assessed at Baseline and at 12-months using the short version of the International Physical Activity Questionnaire (IPAQ-short). The instrument aims to provide internationally comparable data on health-related PA via 9-items asking participants to report frequency (number of days per week) and time (hours and minutes) spent in four different activities (sitting, walking, moderate- and vigorous-intensity activities) over the last 7-days (Craig et al., 2018). According to the scoring protocol, responses were converted from frequency and time to Metabolic Equivalent of Task minutes per week (MET-mins·wk^{-1}). A combined total of weekly PA (Total PA) and a breakdown of walking, moderate- and vigorous-intensity PA in MET-mins·wk^{-1} were calculated (Walking, MPA, and VPA, respectively). Additionally, total weekly minutes spent in moderate-to-vigorous-intensity activities was also calculated (MVPA, min·wk^{-1}). Participants were also asked to report the number of days they performed resistance or strength training activities (RT, days·wk^{-1}) during the last 7-days. Physical activity behavior change (ΔTotal, ΔMPA, ΔVPA, ΔMVPA) was calculated as Post-test minus Baseline assessment so that a positive change indicates an increase in the amount of weekly PA over the intervention (IPAQRG, 2020).

Social support for EX/PA: Perceived SS was assessed using the Perceived Social Support for Exercise Scale. The instrument consists of 13 items in a 1-5 Likert-scale format ranging from "None" to "Very Often" with an additional "Does not apply" option. The scale comprises three subscales with encouragement and discouragement for EX/PA domains from both family (Family Participation and Family Rewards and Punishment) and friends (Friends Participation), for a total of 26 responses (Sallis, Grossman, Pinski, Patterson, & Nader, 1987). According to scoring protocols, all "Does not apply" answers were recoded to "1". The subscales were scored separately by summing up the corresponding items for family or friends participation and rewards and punishments factors. Higher scores represent greater support according to the domain.

Perceived benefits from and barriers to EX/PA: Benefits and Barriers were ascertained via the Exercise Benefits and Barriers Scale (EBBS). The EBBS is a 43-item instrument whereby participants rated their agreement with statements representing benefits (29 items) and barriers (14 items) to EX/PA (Sechrist, Walker, & Pender, 1987). The EBBS was used in its entirety to obtain a total Benefits and Barriers indicator (Benefits and Barriers Total) by reverse scoring the items representing barriers and adding these to the sum of items representing benefits. The higher the overall score, the more positively the participant perceived the benefits in relation to barriers. According to scoring protocols, separate scores for the Benefits Scale (5 subscales; Life Enhancement, Physical Performance, Psychological Outlook, Social Interaction, and Preventive Health) and Barriers Scale (4 subscales; Exercise Milieu, Time Expenditure, Physical Exertion, and Family Discouragement) Subscales, respectively, were also calculated. Finally, subscale scores were standardized by calculating the score/items ratio from each subscale to allow for direct comparison among subscales (Lovell, Ansari, & Parker, 2010). Higher scores on the Benefits Scale and Subscales indicate a more positive perception of EX/PA whereas higher scores on the Barriers Scale and Subscales indicate greater perception of barriers to EX/PA.

4.3.5. Statistical Analyses

For participants with a missing item rate less than 5% on the psychosocial outcomes, median substitution was used to impute scores for missing items (Sechrist et al., 1987). Data were inspected for outliers, normality, and other model assumptions. Descriptive estimates (means, standard deviations, and frequencies) were obtained for all participant Baseline and Post-test characteristics and primary outcome variables. Independent-groups t-tests were utilized to test for group differences when comparing baseline characteristics of completers vs. non-completers. Repeated measures ANOVAs with Tukey post hoc tests (for pairwise comparisons) examined differences among Benefits and Barriers Subscales at Baseline and Post-test measurement points. Repeated measures t-tests were conducted to determine significant differences over time in the primary outcome variables body weight, EX/PA, SS, and Benefits and Barriers. Effect sizes (ES) for changes across time were calculated using standardized mean gain computations as recommended by Becker (1988) following Cohen et al. (1988) suggested criteria for interpretation: small (ES = .2), medium (ES = .5), or large (ES = .8) (Becker, 1988; J. Cohen, 1988).

Pearson bivariate correlational analyses assessed relationships among baseline body weight, attendance, ΔBody weight, ΔPA, ΔSS, and ΔBenefits and Barriers outcomes. Analyses were performed using SPSS 25.0 for Macintosh (Armonk, NY: IBM Corp). Statistical significance was set at $P < .05$ for all tests.

4.4. Results

4.4.1. Descriptive Characteristics of the Participants

Figure 4.1, the consort table, summarizes recruitment and retention of study participants. Of the 124 individuals interested in participating in the DPP, six were excluded due to not meeting program inclusion criteria. Of the 119 individuals eligible for the program, 30 were excluded from the research study due to not meeting research study inclusion criteria and just provided initial screening information, with one withdrawing prior to session 1, for a total of 88 starting the parent research study. Of the research participants starting the program, 59 were not included in the current analysis due to not being population of interest (n= 14 males; n= 9 females aged 18-39 yo), insufficient data, and/or not meeting per protocol completion criteria (n= 36). Participants who met CDC attendance requirements (i.e., considered per-protocol) were included in the current analytical sample (CDC, 2018). Thus, the subsample of middle-aged and older women who completed the intervention and met per protocol criteria was included in the present study (n= 29) (Figure 4.1). Those participants who did not meet the inclusion criteria for the parent research study were still allowed to participate in the DPP. The completers (n = 29) did not differ on baseline age, body weight, or PA behavior characteristics compared with non-completers (n = 36) (all $P > .05$).

Baseline demographic characteristics, attendance, and participation county of the participants are presented in Table 4.1. Weight status, PA behavior, and psychosocial variables over the intervention are presented in Table 4.2. Participants were 60.4 ± 10.6 yo, with the majority being Non-Hispanic White (75.9%), and college graduates (48.3%), and on average obese at baseline (BMI = 35.9 ± 6.7 kg·m^{-2}). Forty eight percent of the participants reported having multiple chronic conditions (e.g., hypertension, hyperlipidemia, arthritis, moderate depression), whereas 65.5% reported being told by a health care provider that they had prediabetes, elevated blood sugar or borderline diabetes. All the participants were free of kidney or liver disease, cancer, Alzheimer's dementia, major depression, congestive heart failure, atrial fibrillation, or any other heart disease (all frequencies = 0; data not shown). All primary outcomes of interest met assumptions of univariate normality based on skewness (< |3|) and kurtosis (< |10|) (Weston & Gore, 2006); thus, no data transformations were conducted.

4.4.2. Changes in Weight Status, Physical Activity, Social Support, and Perceived Benefits and Barriers

Participants completed an average of 24.8 sessions of 27 available (range = 21-27). Body weight (-6.1 ± 5.3 kg; -6.3 ± 5.4%) and BMI (-2.3 ± 2.0 kg·m^{-2}), significantly decreased by the end of the intervention compared with baseline values ($P < .001$). Although not statistically significant and small in effect size, the majority of PA indicators: average Total PA, MPA, VPA, and MVPA increased across the intervention period (ES = .26, .43, .18, and .39, respectively). Both walking and RT behavior were essentially the same at post-test compared with baseline values both $P = 1.00$; respectively) (Table 4.2).

Perceived SS from Family Participation significantly increased on average ~15% over the intervention ($P < .05$; ES = .32), whereas Family Rewards and Punishment and Friends Participation scores essentially did not change (both $P > .05$) (Table 4.2). No significant changes over time were observed in Benefits and Barriers Total score or when assessed by respective subscales (all $P > .05$; Benefits ES = .06 and Barriers ES = -.014). However, significant differences were observed between the subscales at baseline and post-test. For example, Physical Performance and Preventive Health scores were the highest perceived benefits scores at both baseline and post-test ($P < .05$). Preventive Health scores were significantly higher than Life Enhancement and Psychological Outlook Subscales scores at post-test but not at baseline, whereas Social Interaction was consistently the lowest perceived benefit, regardless of measurement time ($P < .05$) (Table 4.2, Figure 4.2A). Similarly, Physical Exertion was consistently the greatest perceived barrier compared to the Exercise Milieu, Time Expenditure and Family Discouragement subscales, regardless of baseline or post-test assessment (all $P < .05$, Figure 4.2B).

4.4.3. Associations Among Changes in Weight Status, Physical Activity, and Psychosocial Outcomes

As presented in Table 4.3, higher attendance was associated with greater weight loss (r = -.46, $P = .01$). Higher baseline BMI was positively associated with Total PA across the intervention (r = .39, P = .046; Figure 4.3; baseline BMI not shown in Table 4.3). An increase (i.e., a positive change) in SS in the form of Family Participation was correlated with an increase in VPA in MET-mins·wk^{-1} in response to the intervention (r = .52, P = .01). Changes in Family Rewards and Punishment or Friends Participation showed no associations with weight loss or changes in EX/PA behavior. Changes in Total MET-mins·wk^{-1} and from walking were not associated with attendance, weight loss or changes in any of the other psychosocial variables of interest in response to the intervention (all $P > .05$).

Specific association patterns were evident between changes in Benefits and Barriers and different intensities of EX/PA. For example, an increased Benefits and Barriers Total score was significantly correlated with a decreased MPA in MET-mins·wk^{-1} and MVPA in min·wk^{-1} (r = -.47 and -.48, respectively), whereas greater scores of perceived Benefits scale was significantly correlated with lower MVPA (r = -.46, all $P < .05$). Lower scores in perceived Barriers scale were significantly associated with higher VPA in MET-mins·wk^{-1} over time (r = -.39; all $P < .05$; Figure 4.4). Observed scores in the perception of Benefits and Barriers scales over the intervention were not associated with Total PA per week (r = -.38 and -.05, both $P > .05$; respectively).

4.5. Discussion

The present study examined the influences of perceived SS and Benefits and Barriers on changes in EX/PA behaviors and whether these changes were linked to changes in body weight in response to a one-year CES delivered DPP Prevent T2 program in middle-older women. A comparison between respective Benefits and Barriers subscales at baseline and post-intervention was also conducted. To our knowledge, the exploration of these potential personal and psychosocial influences of EX/PA behavior and weight loss in response to a community-delivered DPP implementing the latest version of Prevent T2 curriculum in a cohort of middle-older women has not been previously reported.

Our results are confirmatory regarding the effectiveness of the program on weight loss and the observed significant bivariate relationships between SS or Barriers and EX/PA behavior, particularly from vigorous-intensity activities. Conversely, the influence of SS and Benefits and Barriers on total EX/PA, from walking or from moderate-intensity activities, was less convincing, or even contradicting. In the current study, we explored the influence of SS from two key sources: family and friends, as well as benefits from and barriers to EX/PA that were hypothesized as psychosocial determinants of EX/PA behavior, and their association with weight loss. Our primary hypothesis that those women who perceived greater benefits and SS and fewer barriers would experience greater increases in EX/PA behavior, was partially confirmed by our data. However, the secondary hypothesis that observed changes in EX/PA would lead to greater weight loss success in response to the intervention was not confirmed.

Nonetheless, key findings are of interest for longer-term DPP delivery endeavors in a growing sector of our society, middle-older women: a) average weight (6.3%) and BMI reduction were significant and clinically meaningful, with those attending more program sessions experiencing greater weight loss success; b) participants with a greater BMI at baseline had a greater increase in total weekly EX/PA in the program; c) MPA and MVPA increased in response to the intervention, albeit effect sizes were small and insignificant; d) participant perceptions of increased family participation and fewer barriers were both associated with increased VPA; e) participants perceived the degree to which EX/PA 1) enhances physical performance and 2) reduces risk of disease (i.e., preventive health) were the highest benefits, whereas the exertion for EX/PA behaviors was the greatest barrier at the start and completion.

The average weight loss observed in our sample aligns with the clinically significant weight loss goal promoted by Prevent T2 curriculum (5-7%) (CDC, 2020b; Knowler et al., 2002), is close to the average 7% reported in prior clinical DPP (Allaire et al., 2020; Knowler et al., 2009), and higher than the ~4% observed in DPP delivered in real-world settings by nonmedical personnel (Ali, Echouffo-Tcheugui, & Williamson, 2012). This is salient as the weight loss achieved in our study, provided by CES agents in a community context, may foster cost-effectiveness approaches, and ultimately, enhanced dissemination of the DPP. Similarly, the meta-analysis conducted by Ali et al (2012) confirms the presence of better weight loss outcomes in relation to higher attendance, with their study reporting that weight loss increased by .26 percentage point with every additional lifestyle session attended.

Optimal levels of EX/PA have long been recognized as a strong protective factor to prevent obesity and T2DM (Lee et al., 2012; USDHHS, 2018a). Increases in EX/PA are highly recommended for optimal weight loss success (Donnelly et al., 2009; Glechner et al., 2018; Jensen et al., 2014); however, we failed to confirm that greater engagement in EX/PA behavior is related to greater weight loss success in our study. One reason for this lack of effect may be linked to the sensitivity of the measurement of EX/PA used in this protocol (self-report). Even though the EX/PA assessment utilized in the current study has implementation advantages such as practicality and low-cost and was easily administered in community-based settings, it is possible that some EX/PA recall or reporting bias did not allow for a more accurate assessment of EX/PA type, frequency, intensity, and duration over the intervention. However, the self-reported PA is incorporated into the DPP curriculum for Program Recognition (CDC, 2018). Another reason may be that the observed weight loss was mostly due to changes in other health behaviors (e.g., diet quality, stress management) targeted in the Prevent T2 curriculum but not reported in the current study (CDC, 2020b).

Ritchie et al (2018) reported that attainment of the weekly 150-min EX/PA goal in national DPP was associated with total percent weight loss and achieving ≥ 5% weight loss and concluded that failing to attain EX/PA goals may deter retention in the DPP. Even though our analyses focused on changes from baseline to post-intervention EX/PA, no clear associations between EX/PA and attendance were confirmed by our data. Further, days of RT were essentially the same at the end of the intervention compared to baseline values. This suggests that Prevent T2 had no influence on RT activities participation. Given the mounting evidence confirming the positive effect of RT/weight-bearing activities on glucose metabolism and insulin resistance (USDHHS, 2018a), DPP should consider encouraging participants to engage in such activities in particular, and study its effect on primary health outcomes associated with diabetes risk such as weight status and body composition. The present DPP fostered net improvements in EX/PA, especially of moderate and MVPA as shown by borderline medium ES. These findings align with the intensity of the DPP EX/PA goal referred in landmark studies to as completion of 150 minutes of "brisk" PA (Knowler et al., 2002; Kramer, McWilliams, Chen, & Siminerio, 2011; Shawley-Brzoska, 2019), and with higher PA levels reported after completing short-term diabetes prevention programs compared with preprogram levels in prediabetic women (Bean, Dineen, & Jung, 2020; Bean, Dineen, Locke, et al., 2020). However, more thorough information is still required to better determine significance of EX/PA behavior change in response to DPP. This may be assisted by utilizing research-suited assessment tools such as accelerometers or even consumer-level activity trackers/smartphones, which are reasonably priced and accurate, making them advantageous for community-based research.

Regarding SS, in our study we observed that participant perceptions of increased family participation significantly improved in response to the intervention, and that such improvement was associated with increased VPA. In individuals with T2DM, those with greater SS have greater chances of avoiding inactivity (Morowatisharifabad et al., 2019). Prior qualitative evidence from DPP suggests that support received from family members is key to program participation and physically active lifestyles. In this regard, participant's family history of prediabetes/diabetes and the risk factors involved are typically discussed between family members as a sharing of experiences and motivating support for EX/PA and healthy diet, along with motivations to use technology to track between family members (Shawley-Brzoska, 2019). Goal-setting behavior linked to family SS may also be a player (Spiteri et al., 2019) as participants tend to set goals to meet their family member's expectations and will strive to improve, for example, their stamina based on the support from their family or a family goal (Shawley-Brzoska, 2019). Thus, the specific improvement in VPA linked to family SS over our intervention may have a far-reaching impact on improving EX/PA behavior change. Moreover, qualitative studies in prediabetes group educational interventions highlighted that SS is a common theme identified as salient, as stated by this participant "Even the exercise – I didn't feel like a failure- we cheered each other on and supported each other" (Azzi et al., 2020). The current study found no significant improvements in SS from friends. In this regard, perceived SS from other participants in the group sessions may have been of relevance, but it was not specifically assessed as a unique sub-set of friends SS in our sample.

Lifestyle intervention research should also include perceived barriers to promote behavior change (Conn, Burks, Pomeroy, Ulbrich, & Cochran, 2003; Conn, Minor, Burks, Rantz, & Pomeroy, 2003). Literature exploring barriers to EX/PA adoption and maintenance specifically in persons with T2DM exists (Wycherley, Mohr, Noakes, Clifton, & Brinkworth, 2012). However, further research is needed to understand barriers specifically for women living with prediabetes since they may face different conditions including comorbidities, lack of symptoms, and risk perception compared to currently diabetic counterparts (Bean, Dineen, & Jung, 2020). In our study, participant perceptions of fewer barriers were associated with increased VPA. Using a shorter-term DPP intervention but 1-year follow up, Bean et al. (2020) profiled patterns of EX/PA change process, associated strategies, and barriers of women with prediabetes by utilizing a qualitative approach. Their results suggest that participants profiled as *consistently inactive* (i.e., those who described low EX/PA levels before the program, had a slight increase during the program, and were perceived to return to limited EX/PA engagement post-program) were not able to plan for and/or overcome their barriers by using key behavioral strategies to EX/PA engagement (e.g., applying learned knowledge/skills, scheduling EX/PA into day/week, self-monitoring, being self-compassionate) as it was observed in those profiled as *increased/peak in and maintenance* of EX/PA levels in response to the intervention. Indeed, some of the participants in the *increased PA* categories specifically mentioned that learning about heart rate zones, high-intensity interval training, and using a fitness tracker provided by the project, was a valuable part of the program (Bean, Dineen, & Jung, 2020). Moreover, understanding factors related to improved VPA participation in response to DPP is salient as higher intensity activities may positively influence glucose tolerance and insulin sensitivity (Battista et al., 2021; Hu et al., 1999; Ross, Hudson, Stotz, & Lam, 2015; Søgaard et al., 2018).

In our analyses, barriers total score encompassed factors related to the physical or social environment that prevent EX/PA (e.g., exercise milieu), the degree to which EX/PA detracts time from other commitments, exertion for EX/PA behaviors, and the degree to which EX/PA is discouraged by influential relationships such as the partner. We observed that the exertion for EX/PA behaviors was the greatest barrier at the start and post-intervention timepoint. Using a qualitative approach, Casey et al. (2010) found that health concerns not related to diabetes (e.g., arthritis-related chronic pain, sleep apnea, other chronic conditions) often impeded participants from EX/PA participation. This may have implications for EX/PA participation within diabetes prevention initiatives as the physical exertion factor represents participants perception that "exercise is fatiguing" or "exercise is hard work", which can be exacerbated by participants chronic conditions. Casey et al (2010) also pointed out that it is not just that health-concerns play a role but also that participants perceived that EX/PA opportunities such as public fitness centers do not have the expertise to accommodate their needs. In middle-older adults, environmental factors and resources have been identified as the most commonly reported barriers to EX/PA participation; while goal-setting, the belief that an activity will be beneficial, and SS are identified as the most important motivators, especially among middle-aged participants (Spiteri et al., 2019). The degree to which EX/PA a) enhances physical/physiological performance and b) reduces risk of disease (i.e., preventive health) was perceived as the highest benefit by our sample. Even though the fact that improvements in perceived benefits would be associated with increases in EX/PA behaviors appear intuitive, we were not able to confirm this assumption with our data.

Although our novel data are of interest for DPP implementation and effectiveness in a growing sector of the population, it is not without its limitations. First, the EX/PA assessment is based on self-report, which limits the possibility to obtain an objective estimate of frequency, intensity, and duration of the physical activities that participants engaged in and their respective cut-points over the intervention. Second, the study design has an apparent absence of a randomized comparison/control group, which may limit our ability for full causal conclusions. However, pre-post study designs are common for translational purposes because the landmark DPP trial (Knowler et al., 2002; Knowler et al., 2009) had already established that control participants lose very little weight without support (Ali et al., 2012). Third, our sample was physically/cognitively functional and predominantly Non-Hispanic White, which may limit generalizability of the findings to a less functional and more racially/ethnically diverse population. Finally, our results should be interpreted and translated with caution as the implementation trial was conducted under unprecedented global circumstances due to the COVID-19 pandemic. Even though our study was not aimed to be implemented during a pandemic, the program had to be adapted to the situation. Thus, the outcomes of interest may be specific to the context of the pandemic as the circumstances may have affected participants weight status as well as disrupted their EX/PA behaviors, SS, and perceived Benefits and Barriers. Further, the COVID-19 pandemic has been indeed considered a syndemic (Horton, 2020), meaning that some demographic groups have been more disproportionately affected by this event than others in our societies, and in very different ways not captured in our research study or measures.

Our identified weaknesses are balanced with several identified strengths. First, we implemented a prospective trial in real world/community settings delivered by nonmedical personnel, which may foster cost-effectiveness, and ultimately, enhanced dissemination of the DPP. Second, we included the quantitative assessment of determinant psychosocial factors for health behavior change in a middle-older female cohort at an elevated risk for diabetes that, despite being the most common participants, have been collectively under studied in the context of DPP effectiveness. Third, the quantitative approach of our study integrating changes in weight status with behavioral and psychosocial outcomes is considered a strength given the majority of the found evidence resulting from predominantly qualitative inquiry studies (Azzi et al., 2020; Bean, Dineen, & Jung, 2020; Casey et al., 2010; Korkiakangas et al., 2011; Whittemore, 2011)

Irrespective of our results and the identified strengths and limitations of our study, the area of influences of EX/PA behavior change, and weight loss success in middle-older women in the context of DPP implementation remains an important topic of research, clinical, and public health interest, especially in the post pandemic era. Future studies should characterize participants EX/PA behaviors over community based DPPs utilizing objective assessments (e.g., accelerometers, pedometers, activity trackers) and providing specific data on type (e.g., aerobic or muscle-strengthening), frequency, intensity, and time. This may offer additional steps to further inform DPP participant-tailored EX/PA recommendations to foster program effectiveness by meeting individual needs (Ritchie et al., 2018).

Almost identical to our sample, it has been reported that the typical DPP participant is a Non-Hispanic white female who is 55.1 years old and has a BMI of 34 $kg{\cdot}m^{-2}$ (Ali et al., 2012). Thus, future translational DPP should seek to include more ethnically/racially diverse samples, especially Hispanic and Non-Hispanic Black populations, known to have an elevated risk for T2DM and its related complications than Non-Hispanic White counterparts due to health disparities (Golden et al., 2012; Kirk et al., 2008; Menke, Casagrande, Geiss, & Cowie, 2015) . Similarly, future research should examine participants who withdraw from the program or were simply not interested in providing sufficient data to better understand their perceptions and experiences. Finally, a gap in the evidence was found since the majority of the identified literature on psychosocial factors related to EX/PA behavior change within DPP mainly explored barriers/challenges, facilitators, and strategies but not specifically perceived benefits. Therefore, future studies should explore participants perceived benefits from EX/PA and how they relate to actual EX/PA behavior change, which may lead to more conclusive evidence in this regard. Further study of the effectiveness of the current study recommendations may collectively improve understanding for DPP reach regarding middle-older women's health, with special interest in EX/PA as a modifiable health behavior.

Conclusions

Findings from the current study expand understanding of DPP implemented in the community by CES professionals and underscore its effectiveness for clinically meaningful weight loss and improving perceived SS from family participation. Although the program did not significantly increase overall engagement in EX/PA behaviors, participant's perception of family participation and fewer barriers to EX/PA appear to be significantly associated with increased participation in activities of vigorous intensity over the intervention in community-dwelling middle-older women with an elevated risk for T2DM. Alternatively, the role of perceived benefits from EX/PA in the context of translational DPP implementation remains inconclusive. Given the growing number of insufficiently active middle-older women affected by obesity and/or prediabetes based on our demographics, additional translational DPP integrating psychosocial factors related to EX/PA behavior change are warranted to inform lifestyle change initiatives that are inclusive, tailored to participant's needs, and effective.

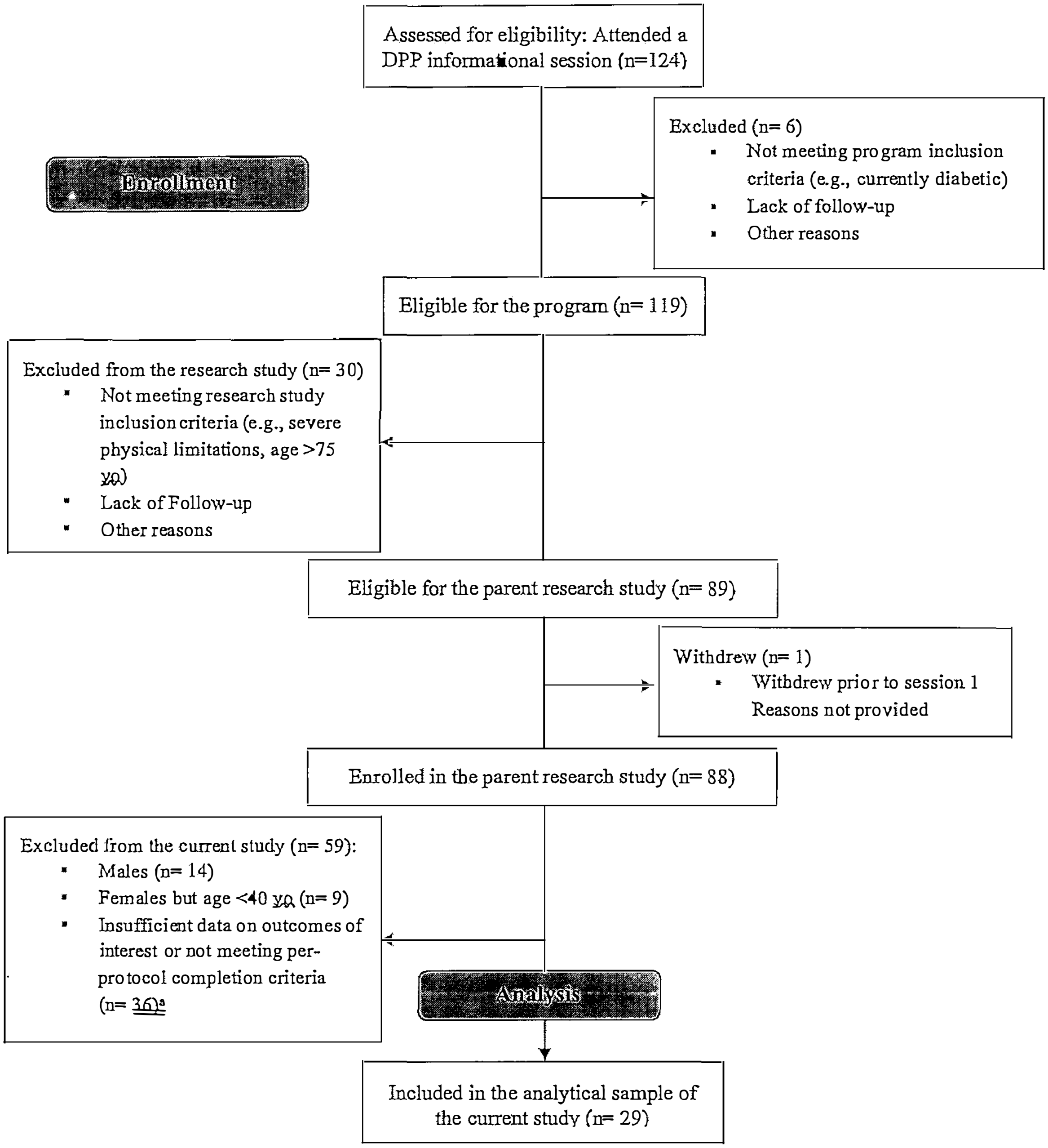

Figure 4.1. Consort table of the recruitment and retention of the participants.

Notes: [a] = Participants considered for "Completers" vs. "Non-completers" comparison analysis;

DPP = Diabetes Prevention Program.

Table 4.1

Initial demographic characteristics and health history of the participants (n = 29).

Characteristic	(M ± SD)		Range
Age (years)	60.4 ± 10.6		41-75
Attendance (sessions)	24.8 ± 1.3		21-27
Ethnicity	**n**	%	
Non-Hispanic White	22	75.9	
Non-Hispanic Black	4	13.8	
Hispanic	2	6.9	
Other	1	3.4	
Education level	**n**	%	
High school graduate / GED	3	10.3	
Some college or technical school	12	41.4	
College graduate	14	48.3	
Chronic conditions / Health history	n	%	
Prediabetes, elevated blood sugar or borderline diabetes diagnosis	19	65.5	
Hypertension	18	62.1	
Hyperlipidemia	11	37.9	
Arthritis	7	24.1	
Moderate depression	5	17.2	
GDM	3	10.3	
County in Georgia	n	%	
Chattooga	6	20.7	
Crisp	5	17.2	
Cobb	4	13.8	
Elbert	3	10.3	
Clarke	2	6.9	
Coweta	2	6.9	
Spalding	2	6.9	
Forsyth	1	3.4	
Gilmer	1	3.4	
Laurens	1	3.4	
Oglethorpe	1	3.4	
Madison	1	3.4	

Notes: M = Mean; SD = Standard deviation; GED = General Educational Development; GDM = Gestational Diabetes Mellitus.

Table 4.2

Outcome variables by measurement time of the program (n=29).

Variable	Baseline (M ± SD)	Post-test (M ± SD)	Δ (M ± SD)	t (*P-value*)*
Body weight (kg)	94.4 ± 21.3	88.2 ± 20.1	**-6.1 ± 5.3**	**6.1 (<.001)**
BMI (kg·m^{-2})	35.9 ± 6.7	33.6 ± 6.2	**-2.3 ± 2.0**	**6.1 (<.001)**
Physical Activity				
Total PA (MET-mins·wk^{-1})	1616.1 ± 1644.1	2051 ± 1762.3	434.9 ± 1720.3	-1.3 (.21)
Walking (MET-mins·wk^{-1})	849.2 ± 1106.5	858.7 ± 816.5	9.5 ± 1085.5	-.04 (.96)
MPA (MET-mins·wk^{-1})	443.8 ± 680.8	758.5 ± 782.3	314.6 ± 948.4	-1.7 (.10)
VPA (MET-mins·wk^{-1})	323.1 ± 621.0	433.8 ± 598.6	110.8 ± 722.3	-.78 (.44)
MVPA (min·wk^{-1})	156.5 ±227.3	243.8 ± 225.0	87.3 ± 273.1	-1.6 (.12)
RT (d·wk^{-1})	1.2 ± 2.1	1.2 ± 1.7	.00 ± 2.3	.00 (1.00)
Social Support				
Family Participation	21.1 ± 9.1	24.2 ± 10.1	3.0 ± 7.3	**-2.2 (.04)**
Family Rewards and Punishment	3.8 ± 1.3	4.0 ± 1.3	.18 ± 1.5	-.63 (.53)
Friends Participation	17.7 ± 7.3	17.8 ± 8.6	.04 ± 7.1	-.03 (.98)
EBBS				
Benefits and Barriers Total Score	130.8 ± 12.9	132.3 ± 14.3	1.6 ± 9.4	-.89 (.38)
Benefits Scale	89.9 ± 11.0	90.6 ± 11.1	.72 ± 8.1	-.48 (.63)
Subscales				
Life Enhancement	3.1 ± .51[AB]	3.1 ± .48[ABG]	-.04 ± .39	.54 (.60)
Physical Performance	3.3 ± .44[AC]	3.3 ± .42[AC]	-.00 ± .39	.06 (.95)
Psychological Outlook	3.0 ± .44[CD]	3.1 ± .49[CDF]	.10 ± .43	-1.2 (.23)
Social Interaction	2.7 ± .48[BCDE]	2.7 ± .51[BCDE]	.01 ± .42	-.11 (.91)
Preventive Health	3.2 ± .55[E]	3.4 ± .42[EFG]	.11 ± .52	-1.2 (.24)
Barriers Scale	29.1 ± 5.3	28.3 ± 6.3	-.83 ± 4.0	1.1 (.28)
Subscales				
Exercise Milieu	2.0 ± .38	1.9 ± .48	-.11 ± .35	1.7 (.10)
Time Expenditure	1.9 ± .56	1.9 ± .66	-.06 ± .48	.64 (.52)
Physical Exertion	2.6 ± .64[†]	2.5 ± .64[†]	-.03 ± .40	.46 (.65)
Family Discouragement	1.9 ± .79	1.9 ± .81	.05 ± .56	-.50 (.62)

Notes: *Bold values denote significant mean differences in response to the intervention; [ABCDE] = Same letters denote pairwise significant differences among Benefits subscales within measurement time point, [†] = Indicates significantly different Barriers subscale; M = Mean; SD = Standard deviation; Δ = Mean change; BMI = Boy Mass Index; EBBS = Exercise Benefits and Barriers Scale; MPA = Moderate-intensity physical activity; VPA = Vigorous-intensity physical activity; MVPA = Moderate-to-Vigorous- intensity physical activity; RT = Resistance training; MET-mins·wk^{-1}=Metabolic equivalents of task-minutes per week.

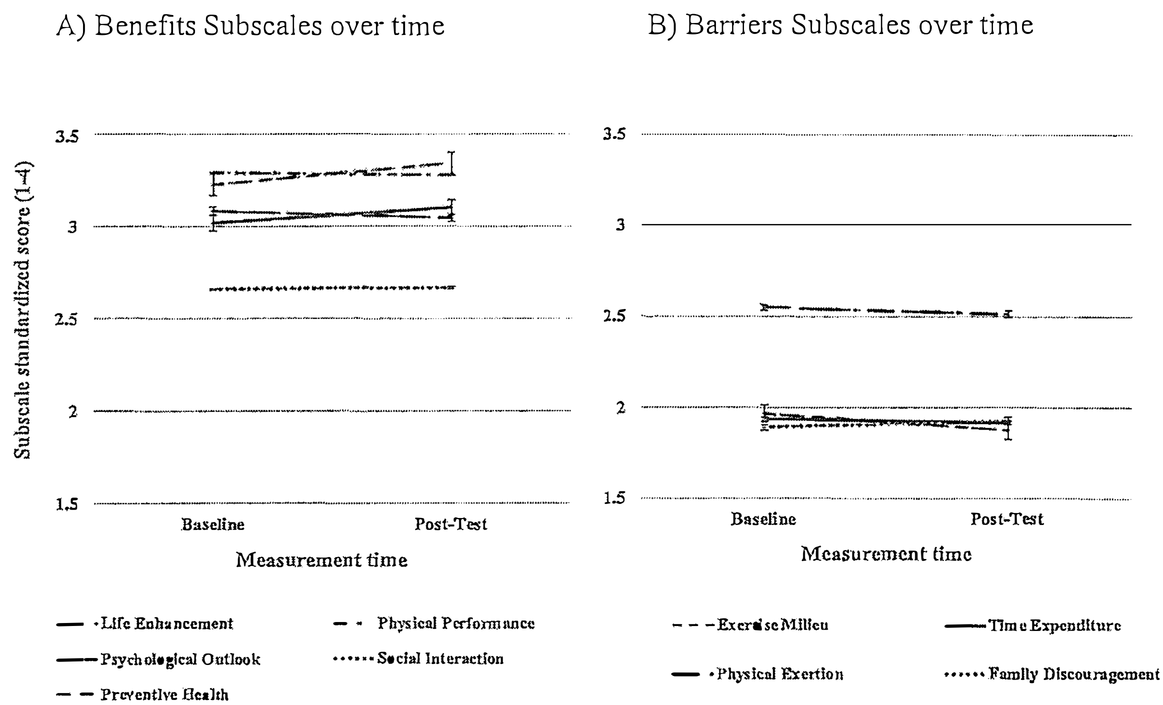

Figure 4.2. Comparisons among Benefits and Barriers Subscales standardized scores over time (n = 29).

Table 4.3

Bivariate correlation matrix for change in weight status, physical activity, and psychosocial outcomes of interest (n = 29).

	1	2	3	4	5	6	7	8	9	10	11
1. Attendance	--										
2. ΔBody weight (kg)	-.46*	--									
Physical Activity											
3. ΔTotal PA (MET-mins·wk^{-1})	-.15	-.03	--								
4. ΔMPA (MET-mins·wk^{-1})	-.23	-.20	.57*	--							
5. ΔVPA (MET-mins·wk^{-1})	.29	-.13	.60**	.09	--						
6. ΔMVPA (min·wk^{-1})	-.14	-.03	.71**	.94**	.41*	--					
Social Support											
7. ΔFamily Participation	.28	-.01	.34	.01	.52*	.19	--				
8. ΔFamily Rewards and Punishment	.01	.31	-.26	-.11	.03	-.08	.06	--			
9. ΔFriends Participation	-.21	.06	-.13	-.29	.21	-.16	.12	.31	--		
EBBS											
10. ΔBenefits and Barriers Total	.004	-.04	-.32	-.47*	-.10	-.48*	-.02	-.003	-.001	--	
11. ΔBenefits	-.08	-.03	-.38	-.37	-.31	-.46*	-.12	.11	-.04	.90**	--
12. ΔBarriers	-.18	.03	-.05	.34	-.39*	.19	-.19	.22	-.08	-.51*	-.10

Notes: *$P \leq .05$; ** $P \leq .001$; Δ = Net change; MET-mins·wk^{-1} = Metabolic equivalents of task-minutes per week; MPA = Moderate-intensity physical activity; VPA = Vigorous-intensity physical activity; MVPA = Moderate-to-Vigorous intensity physical activity; EBBS = Exercise Benefits and Barriers Scale.

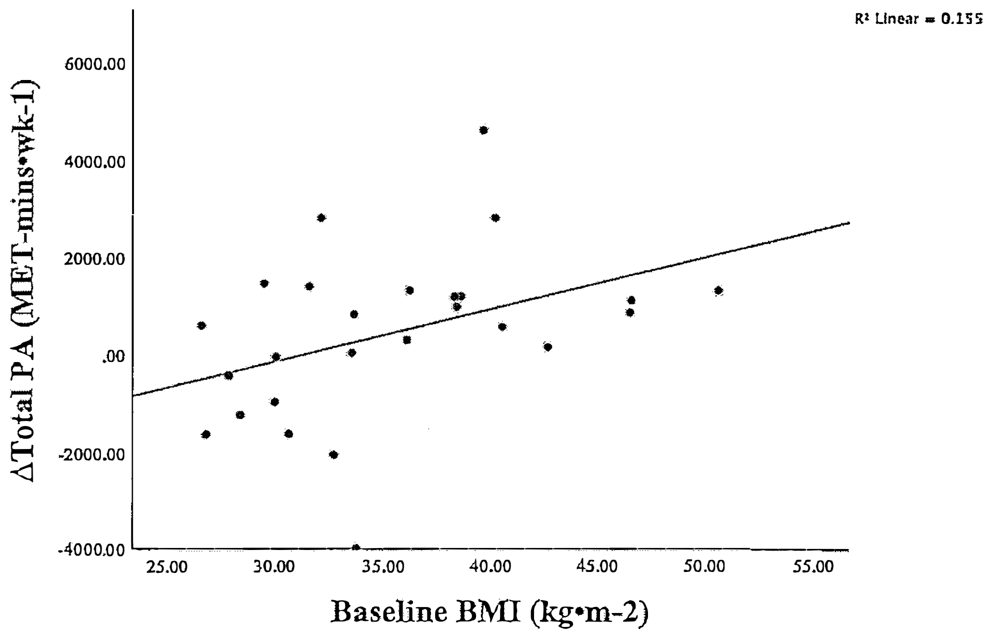

Figure 4.3. *Bivariate correlation between baseline BMI and change in total weekly PA over the intervention (n = 29).*

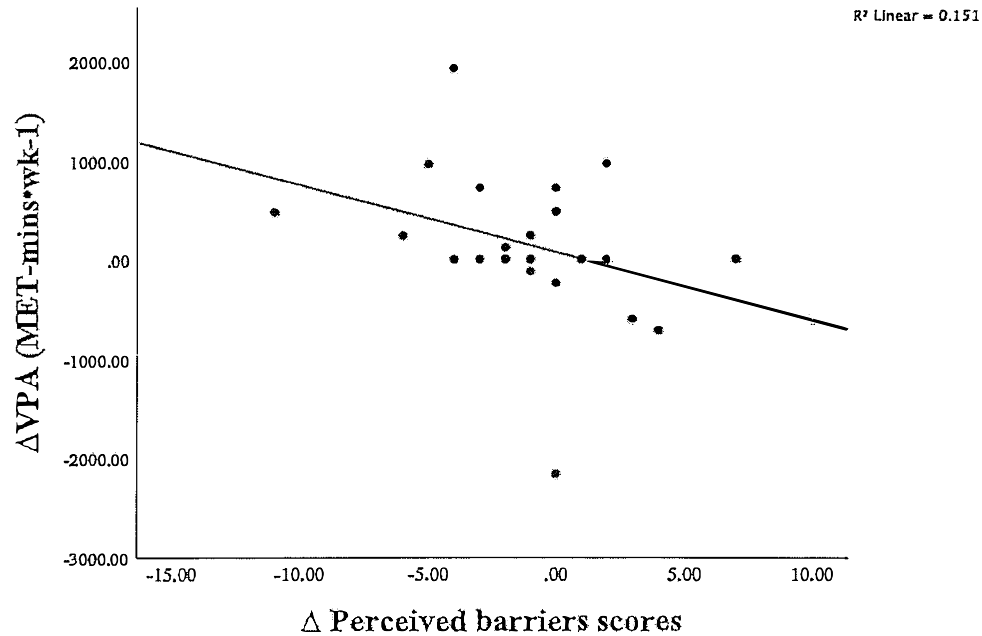

Figure 4.4. *Bivariate correlation between change in perceived Barriers to EX/PA and Vigorous-intensity activities over the intervention (n = 29).*

CHAPTER 5

SUMMARY AND CONCLUSIONS

The purpose of this dissertation was to examine the relative influence of EX/PA, health status, and psychosocial variables on middle-older women's sexual and menopausal well-being, and the role of SS and Benefits and Barriers perceptions on EX/PA behavior change and related weight loss in the context of a long-term community based DPP implementation, using objective and self-reported assessments. Two independent secondary data analyses were completed from two different projects, one cross-sectional and one interventional. Summary of the two datasets is as follows:

Dissertation Aim 1: Middle-Aged Early Postmenopausal Women; Sexual Well-being, Cross-sectional Project: A larger cross-sectional project (n = 86) that primarily investigated accelerometer-measured EX/PA behaviors, psychosocial constructs, diet, and DEXA measured body composition (including adiposity) and physical function in middle-aged postmenopausal women was accessed.

Dissertation Aim 2: Middle-aged and Older Women; Diabetes Prevention Program, Intervention Project): A larger one-year effectiveness-implementation trial (n = 88) that primarily aimed to determine the effectiveness of the DPP Prevent T2 with a social media enhancement, implemented in the context of Cooperative Extension Services, on weight status, diet quality, EX/PA, in overweight and obese individuals at a higher risk for T2DM was utilized.

In this context and utilizing these two data sets, the primary aims of this dissertation were two-fold: 1) to examine the relative influence of objective MVPA and adiposity on sexual and menopausal well-being in midlife postmenopausal women while controlling for health status (total number of comorbidities and medications) and psychosocial wellbeing (depressive symptoms and perceived stress scores) and 2) to determine the influence of perceived SS and Benefits and Barriers on improvements in EX/PA behaviors and whether these improvements were linked to change in body weight in response to the DPP.

Primary Aim 1: Physical inactivity, unhealthy weight status, prevalence of chronic conditions, and psychosocial distress are common complaints for early menopausal women and are linked to reductions in sexual well-being and MENQOL. It is theoretically plausible that EX/PA behavior would positively influence midlife women's sexual well-being and MENQOL given the recognized benefits of EX/PA on adiposity, chronic disease prevention, and psychosocial well-being. However, the systematic integration of these variables, as they impact sexual well-being and MENQOL, has not been well-characterized in this growing sector of the population, especially when utilizing objective or research-level measures to assess EX/PA behavior and adiposity. To this end, 68 overweight or obese early postmenopausal women were assessed for MVPA via accelerometry, adiposity via DEXA, health status, depressive symptoms, perceived stress, sexual well-being and MENQOL. Quantitative analyses revealed that health status, as assessed by number of comorbidities and medications, and depressive symptoms negatively impacted sexual and menopausal well-being. Alternatively, MVPA did not appear to play a significant independent role in explaining sexual well-being beyond health status or depression scores. In addition, beyond the myriad well-established benefits of habitual MVPA for physical and psychosocial health, the potential positive implications of EX/PA on sexual well-being and MENQOL may be in fact indirect.

Primary Aim 2: Females are at greater risk of develop T2DM with advancing age, and subsequently greater risk for disabling and life-threatening chronic diseases associated with T2DM compared to males. EX/PA is a key strategy for weight management and the prevention of T2DM, especially as a part of the DPP. However, despite the latest version of the DPP Prevent T2 curriculum emphasizing EX/PA and being grounded in social support and benefits and barriers related strategies, the systematic and quantitative study of these psychosocial variables and EX/PA behaviors and weight loss outcomes in response to community based DPP implementation is scarce, especially in middle-older females, who are known to be the most common Prevent T2 participants. To address primary aim 2, a delineated sub-study (n = 29) of a one-year implementation trial of DPP Prevent T2 curriculum delivered in community settings was conducted in a middle-older women sample. In response to the intervention, participants experienced clinically meaningful weight loss (6.3%), with those attending more program sessions experiencing greater loss. Moderate PA and MVPA increased, albeit effect sizes were small and insignificant. Participant perceptions of increased SS from family participation and fewer barriers were both associated with increased vigorous PA. Participants perceived the degree to which EX/PA 1) enhances physical performance and 2) reduces risk of disease to be the highest benefits, whereas the exertion for EX/PA behaviors was consistently the greatest barrier.

In conclusion, the first study of this dissertation project provided novel evidence that health status and depressive symptoms negatively impact sexual and menopausal well-being in middle-older early menopausal women. Thus, future research should consider integrated study designs exploring the effect of increased PA behavior on sexual well-being through the favorable effects on comorbidities and depressive symptoms in early menopausal women known to be afflicted with a reduction in sexual quality of life. In addition, evidence from the second study of this dissertation project suggests that the DPP implemented in the community by Cooperative Extension Services professionals, is effective for clinically meaningful weight loss and improves perceived SS from family participation. Although the program did not significantly increase overall engagement in EX/PA behaviors, participant's perception of family participation and fewer barriers to EX/PA appear to be significantly associated with increased participation in physical activities of vigorous intensity over the intervention. The role of perceived benefits from EX/PA in the context of translational DPP implementation remains inconclusive. Thus, future DPP translational studies should consider strategies to increase SS and reduce barriers to EX/PA to enhance effectiveness in community-dwelling middle-older women with an elevated risk for T2DM.

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APPENDIX A

MANUSCRIPT 1 QUESTIONNAIRES

Subject No.	Date of Visit	Visit	Reviewed by:	Data entered by:
☐☐☐☐	☐☐ MM ☐☐ DD ☐☐☐☐ YYYY	☐☐	☐☐☐	☐☐☐

Health History and Demographics Questionnaire

Date of Birth: Age:

Have you recently experienced any of the following?

Pain or discomfort in the chest, neck, jaw, arms, or other	YES	NO
Heartbeats or palpitations that feel more frequent or forceful than usual or feeling that your heart is beating very rapidly.	YES	NO
Unusual dizziness or fainting.	YES	NO
Shortness of breath while lying flat or a sudden difficulty in breathing that wakes you up while you are sleeping.	YES	NO
Shortness of breath at rest or with mild exertion (like walking two blocks	YES	NO
Ankle swelling unrelated to injury.	YES	NO
Feeling lame or pain in your legs brought on by walking.	YES	NO
Unusual fatigue with usual activities.	YES	NO
Have you had any recent illnesses or recently received antibiotics? If so, please explain:	YES	NO

Health History

Have you ever been diagnosed with a heart murmur?	YES	NO
Have you ever had a heart attack?	YES	NO
Have you been diagnosed with a past or present cardiovascular disease?	YES	NO
Do you have any significant heart rhythm disorders?	YES	NO
If yes, is it a chronic disorder?	YES	NO
Have you been diagnosed with hypertension?	YES	NO
Have you been diagnosed with peripheral vascular disease?	YES	NO

Subject No.	Date of Visit (MM DD YYYY)	Visit	Reviewed by:	Data entered by:

Do you have a history or current diagnosis of anemia? YES NO
If yes, how has this been treated?

Have you ever been diagnosed with a pulmonary disease such as asthma or emphysema? YES NO

Do you have obstructive sleep apnea? YES NO

Are you epileptic? YES NO

Do you have arthritis? YES NO
If so please describe where and severity (i.e., left knee, moderate pain):

Have you been diagnosed with diabetes? YES NO
If yes, please indicate:
TYPE I TYPE II

Have you been diagnosed with any kind of cancer? YES NO
If so please identify type of cancer and date of diagnosis:

Do you have osteoporosis? YES NO

Do you have a hearing loss or wear a hearing aid? YES NO

Have you recently been hospitalized? YES NO
If so please explain why and for how long:

Have you ever lost consciousness as a result of hitting your head?
If yes:
When did this occur? YES NO

Where did you hit your head?

How long were you unconscious?

Subject No.	Date of Visit (MM DD YYYY)	Visit	Reviewed by:	Data entered by:

Have you had any knee, hip, or ankle surgeries in the last year? YES NO

If yes, please describe (i.e., left knee to repair torn ligament) and include any physical limitations you current experience even after the surgery

Within the past 6 months, have you accidentally fallen where you landed on the floor/ground or hit an object such as a stair, chair, or other furniture? YES NO

If yes:

Approximately how many times would you say that you have fallen in the last 6 months? ___________

How many of those falls were serious enough to cause injury? ___________

How many of those falls resulted in you seeking medical care? ___________

How many of those falls resulted in you being hospitalized? ___________

How much sleep did you get last night? __________ hours

How much sleep do you typically get each night? __________ hours

Have you ever smoked in the past? YES NO

If yes:

How many years did you smoke? ______ years

Approximately how much did you smoke each day? ______ cigarettes

How long ago did you quit smoking? ______ years

How often would you rate your stress level as high?

☐Occasionally

☐Frequently

☐Constantly

Subject No.	Date of Visit (MM DD YYYY)	Visit	Reviewed by:	Data entered by:

*Is there **anything** else you feel we should know about you or your current/past health?* YES NO

If yes, please explain:

Medications: Please indicate if you take the following medicine or drugs (circle all that you take), and list all other medicines or drugs you presently take and include the amount taken (dosage) and how often. Please include over-the-counter medicines as well as prescription medicine.

Medicine/Drug/Supplement Name	Dosage (i.e. mg, units, etc.)	Frequency Taken (i.e., times per day, week, etc.)
Anti-inflammatory drugs (e.g. aspirin, ibuprofen)		
Cholesterol Medications (e.g. Lipitor, Crestor, Mevacor, Vytorin)		
Hypothyroidism drugs (e.g. Synthroid)		
Blood pressure medications (e.g. Atenolol, HCTZ)		
Any Rx Medications, OTC medications, Vitamins or supplements:		

Subject No.	Date of Visit	Visit	Reviewed by:	Data entered by:
	MM DD YYYY			

Demographics

Are you currently married? ☐ Yes ☐ No

If no, please specify:

☐ Never married

☐ Living with partner

☐ Widowed

☐ Separated

☐ Divorced

☐ Other

How many years have you been in your current marital situation? _____ years

How many times have you been married? _____ times
If you have never been married, please write "0".

What is your race? *(Please specify all categories that apply.)*

☐ Asian/Pacific

☐ Black

☐ Hispanic

☐ Indian/Alaskan

☐ White

What is your total gross household annual income (before taxes and deductions)?

☐ $0-$14,999	☐ $15,000-$29,999	☐ $30,000-$44,999	☐ $45,000-$59,999
☐ $60,000-$74,999	☐ $75,000-$89,999	☐ $90,000 and above	☐ I choose not to answer

Subject No.	Date of Visit	Visit	Reviewed by:	Data entered by:
	MM / DD / YYYY			

How many years of education have you completed? ___________ years

For example: If you completed high school in the USA, you would have had 12 years of education.

	Number of years attended	Degree?	Specify the major area of study
Elementary (grades 1-8)	_____ years	NA	
High school (grades 9-12)	_____ years	Yes No	
Vocational/Technical School	_____ years	Yes No	
2-year College	_____ years	Yes No	
4 –year College	_____ years	Yes No	
Graduate School	_____ years	Yes No	
Professional School	_____ years	Yes No	

What is your current employment status?

☐	Full time – working at least 35 hours/week
☐	Part time – working less than 35 hours/week
☐	Laid-off or unemployed, but looking for work
☐	Laid-off or unemployed, but not looking for work
☐	Retired, not working at all
☐	Retired, working part-time
☐	Disabled
☐	Full time homemaker
☐	Other, *please specify:* ______________________

What is your primary occupation (the one you work most hours a week)? If you are retired and not working, what WAS your primary occupation?

Subject No.	Date of Visit	Visit	Reviewed by:	Data entered by:
☐☐☐☐	☐☐ MM ☐☐ DD ☐☐☐☐ YYYY	☐☐	☐☐☐	☐☐☐

Do you have any children? ☐ Yes ☐ No

If yes, how many? ______

How many people live in your household including yourself?

_____ adults (at least 18 years of age)

_____ children (less than 18 years of age)

Other than yourself and your spouse or significant other, please describe any additional household members:

Children	Gender and Age(s)
Grandchildren	Gender and Age(s)
Other relatives	Gender and Age(s)
Other non-relatives	Gender and Age(s)

Subject No.	Date of Visit	Reviewed by:	Data entered by:
	MM DD YYYY		

Greene Climacteric Scale

Please indicate the extent to which **you have been bothered by any of these symptoms in the last month.** Circle the appropriate response.

Symptoms	Not at all	A little	Quite a bit	Extremely
1. Heart beating quickly or strongly	0	1	2	3
2. Feeling tense or nervous	0	1	2	3
3. Difficulty in sleeping	0	1	2	3
4. Excitable	0	1	2	3
5. Attacks of panic	0	1	2	3
6. Difficulty in concentrating	0	1	2	3
7. Feeling tired or lacking in energy	0	1	2	3
8. Loss of interest in most things	0	1	2	3
9. Feeling unhappy or depressed	0	1	2	3
10. Crying spells	0	1	2	3
11. Irritability	0	1	2	3
12. Feeling dizzy or faint	0	1	2	3
13. Pressure or tightness in head or body	0	1	2	3
14. Parts of body feel numb or tingling	0	1	2	3
15. Headaches	0	1	2	3
16. Muscle and joint pains	0	1	2	3
17. Loss of feeling in hands and feet	0	1	2	3
18. Breathing difficulties	0	1	2	3
19. Hot flashes	0	1	2	3
20. Sweating at night	0	1	2	3
21. Loss of interest in sex	0	1	2	3

Menopause Specific Quality of Life Questionnaire

For each of the items below, indicate by checking "Yes" or "No" whether you have experienced the problem in the PAST WEEK. If you have, rate the degree to which you have been *bothered* by the problem.

			Not at all bothered →						Extremely bothered
			0	1	2	3	4	5	6
1. HOT FLUSHES OR FLASHES	☐ No	☐ Yes →	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
2. NIGHT SWEATS	☐ No	☐ Yes →	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
3. SWEATING	☐ No	☐ Yes →	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
4. DISSATISFACTION WITH MY PERSONAL LIFE	☐ No	☐ Yes →	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
5. FEELING ANXIOUS OR NERVOUS	☐ No	☐ Yes →	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
6. POOR MEMORY	☐ No	☐ Yes →	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
7. ACCOMPLISHING LESS THAN I USED TO	☐ No	☐ Yes →	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
8. FEELING DEPRESSED, DOWN OR BLUE	☐ No	☐ Yes →	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
9. BEING IMPATIENT WITH OTHER PEOPLE	☐ No	☐ Yes →	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
10. FEELINGS OF WANTING TO BE ALONE	☐ No	☐ Yes →	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
11. FLATULENCE (WIND) OR GAS PAINS	☐ No	☐ Yes →	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
12. ACHING IN MUSCLES AND JOINTS	☐ No	☐ Yes →	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
13. FEELING TIRED OR WORN OUT	☐ No	☐ Yes →	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
14. DIFFICULTY SLEEPING	☐ No	☐ Yes →	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
15. ACHES IN BACK OF NECK OR HEAD	☐ No	☐ Yes →	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
16. DECREASE IN PHYSICAL STRENGTH	☐ No	☐ Yes →	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6

Menopause Specific Quality of Life Questionnaire *(Con't.)*

For each of the items below, indicate by checking "Yes" or "No" whether you have experienced the problem in the PAST WEEK. If you have, rate the degree to which you have been *bothered* by the problem.

Not at all bothered → Extremely bothered

	No	Yes	0	1	2	3	4	5	6
17. DECREASE IN STAMINA	□ No	□ Yes →	□ 0	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6
18. LACK OF ENERGY	□ No	□ Yes →	□ 0	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6
19. DRY SKIN	□ No	□ Yes →	□ 0	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6
20. WEIGHT GAIN	□ No	□ Yes →	□ 0	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6
21. INCREASED FACIAL HAIR	□ No	□ Yes →	□ 0	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6
22. CHANGES IN APPEARANCE, TEXTURE OR TONE OF MY SKIN	□ No	□ Yes →	□ 0	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6
23. FEELING BLOATED	□ No	□ Yes →	□ 0	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6
24. LOW BACKACHE	□ No	□ Yes →	□ 0	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6
25. FREQUENT URINATION	□ No	□ Yes →	□ 0	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6
26. INVOLUNTARY URINATION WHEN LAUGHING OR COUGHING	□ No	□ Yes →	□ 0	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6
27. DECREASE IN MY SEXUAL DESIRE	□ No	□ Yes →	□ 0	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6
28. VAGINAL DRYNESS	□ No	□ Yes →	□ 0	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6
29. AVOIDING INTIMACY	□ No	□ Yes →	□ 0	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6
30. BREAST PAIN OR TENDERNESS	□ No	□ Yes →	□ 0	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6
31. VAGINAL BLEEDING OR SPOTTING	□ No	□ Yes →	□ 0	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6
32. LEG PAINS OR CRAMPS	□ No	□ Yes →	□ 0	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6

APPENDIX B

MANUSCRIPT 2 QUESTIONNAIRES

Participant Eligibility Screening Form

Today's Date *(mm/dd/yyyy)*:

First Name:	**Last Name:**
E-mail Address:	**Phone Number:**
Insurance: ☐ Yes ☐ No	
Date of Birth *(mm/dd/yyyy)*:	**Sex** *(check one)*: ☐ Male ☐ Female ☐ Prefer not to answer
County of Residency:	**Ethnicity** *(check one)*: ☐ Hispanic or Latino ☐ Not Hispanic or Latino
Race *(check all that apply)*: ☐ American Indian or Alaska Native ☐ Asian or Asian American ☐ Black or African American	☐ Native Hawaiian or Other Pacific Islander ☐ White
Education: ☐ Some high school ☐ Graduated from high school or got a GED ☐ Some college or technical school ☐ College graduate	
Height: ______ feet ______ inches	**Starting Weight** *(weight taken today)*: ________ pounds

In the past year, have you been told by a doctor or health care provider that you have prediabetes, elevated blood sugar, or borderline diabetes? *(check one)*:

☐ Yes ☐ No

If yes, what type of blood test was performed? *(check all that apply)*

☐ Fasting glucose test (blood test where blood was drawn with needle)

☐ Hemoglobin A1c test

☐ Oral Glucose Tolerance Test

☐ There was a blood test, but I don't know / don't remember what kind

If you are a woman, have you ever been told by a health care provider that you had Gestational Diabetes Mellitus (GDM) during pregnancy? *(check one)*: ☐ Yes ☐ No

Current Health Questionnaire

In the last year, have you tried to lose weight? ☐ Yes ☐ No If yes, how many times ☐☐ If you have tried to lose weight, what method(s) have you used to try to lose weight?
Would you say that in general your health is: ☐ Excellent ☐ Very Good ☐ Good ☐ Fair ☐ Poor
How often do you use nutrition labels to choose foods? ☐ Never ☐ Rarely ☐ Sometimes ☐ Often ☐ Always
Are you currently pregnant? ☐ Yes ☐ No
Do you have any of the following health issues now *(check all that apply)*: ☐ Kidney Disease ☐ Liver Disease ☐ Cancer ☐ Alzheimer's or other dementia ☐ Congestive Heart Failure ☐ Atrial Fibrillation (A-fib) ☐ Any problems with your body that would keep you from being able to walk
Has your doctor ever told you that you have *(check all that apply)*: ☐ High blood pressure ☐ High cholesterol ☐ Heart Disease ☐ Arthritis ☐ Major Depression ☐ Moderate Depression

Physical Activity Readiness Questionnaire

Has your doctor ever said that you have a heart condition and that you should only perform physical activity recommended by a doctor? ☐ Yes ☐ No
Do you feel pain in your chest when you perform physical activity? ☐ Yes ☐ No
In the past month, have you had chest pain when you were not performing any physical activity? ☐ Yes ☐ No
Do you lose your balance because of dizziness or do you ever lose consciousness? ☐Yes ☐ No
Do you have a bone or joint problem that could be made worse by a change in your physical activity? ☐ Yes ☐ No
Is your doctor currently prescribing any medication for your blood pressure or for a heart condition? ☐ Yes ☐ No
Do you know of <u>any</u> other reason why you should not engage in physical activity? ☐ Yes ☐ No

<u>For Lifestyle Coach Use Only</u>

Prediabetes determined by: ☐ Blood test ☐ GDM ☐ Risk Screening Test

BMI (lbs/inches^2) x 703: ________________

Assigned Participant ID # ____________________ Form revised: 10-07-2019

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

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

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

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

   _____ **days per week**

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

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

   _____ **hours per day**

   _____ **minutes per day**

   ☐ Don't know/Not sure

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

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

   _____ **days per week**

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

SHORT LAST 7 DAYS SELF-ADMINISTERED version of the IPAQ. Revised August 2002.

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

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

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

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

_____ **days per week**

☐ No walking → *Skip to question 7*

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

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

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

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

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

Think about all the resistance or strength training activities that you did in the last 7 days. Resistance or strength training activities refer to activities that are intended to increase muscular strength or endurance. They can, but do not have to include the use of free weights, machines, or resistance bands.

During the **last 7 days**, on how many days did you perform **resistance or strength training** activities?

○ Days per week ____

How much time did you usually spend performing **resistance or strength training** activities on one of those days? (Example: 1 hour per day, 30 minutes per day OR 90 minutes per day)

○ Hours per day ____

○ Minutes per day ____

Social Support and Exercise

The following is a list of things people might do or say to someone who is trying to exercise regularly. If you are not trying to exercise, then some of the questions may not apply to you, but please read statement and give an answer to every question.

Rate each question twice. Under Family, rate how often your family members and/or anyone living in your household has said or done what is described during the last 3 months. Under Friends, rate how often your friends, acquaintances, or co-workers have said or done what is described during the last 3 months.

SAMPLE:	Family	Friends
If my family rarely does physical activities with me, and my friends very often do, I would answer like this:		
Did physical activities with me.	2	5

None	Rarely	A few times	Often	Very often	Does not apply
1	2	3	4	5	8

Please write *one* number from the rating scale shown above in each space:

During the past 3 months, my Family (or members of my household) or Friends have...

		Family	Friends
1.	Exercised with me.	1.______	1.______
2.	Offered to exercise with me.	2.______	2.______
3.	Gave me helpful reminders to exercise. ("Are you going to exercise tonight?").	3.______	3.______
4.	Gave me encouragement to stick with my exercise program.	4.______	4.______
5.	Changed their schedule so we could exercise together.	5.______	5.______
6.	Discussed exercise with me.	6.______	6.______
7.	Complained about the time I spend exercising	7.______	7.______
8.	Criticized me or made fun of me for exercising.	8.______	8.______
9.	Gave me rewards for exercising (Bought me something or gave me something I like)	9.______	9.______
10.	Planned for exercise on recreational outings.	10._____	10._____
11.	Helped plan events around my exercise.	11._____	11._____
12.	Asked me for ideas on how *they* can get more exercise.	12._____	12._____
13.	Talked about how much they like to exercise.	13._____	13._____

EXERCISE BENEFITS/BARRIERS SCALE

DIRECTIONS: Below are statements that relate to ideas about exercise. Please indicate the degree to which you agree or disagree with the statements by circling SA for strongly agree, A for agree, D for disagree, or SD for strongly disagree.

		Strongly Agree	Agree	Disagree	Strongly Disagree
1.	I enjoy exercise.	SA	A	D	SD
2.	Exercise decreases feelings of stress and tension for me.	SA	A	D	SD
3.	Exercise improves my mental health.	SA	A	D	SD
4.	Exercising takes too much of my time.	SA	A	D	SD
5.	I will prevent heart attacks by exercising.	SA	A	D	SD
6.	Exercise tires me.	SA	A	D	SD
7.	Exercise increases my muscle strength.	SA	A	D	SD
8.	Exercise gives me a sense of personal accomplishment.	SA	A	D	SD
9.	Places for me to exercise are too far away.	SA	A	D	SD
10.	Exercising makes me feel relaxed.	SA	A	D	SD
11.	Exercising lets me have contact with friends and persons I enjoy.	SA	A	D	SD
12.	I am too embarrassed to exercise.	SA	A	D	SD
13.	Exercising will keep me from having high blood pressure.	SA	A	D	SD
14.	It costs too much to exercise.	SA	A	D	SD
15.	Exercising increases my level of physical fitness.	SA	A	D	SD
16.	Exercise facilities do not have convenient schedules for me.	SA	A	D	SD
17.	My muscle tone is improved with exercise.	SA	A	D	SD
18.	Exercising improves functioning of my cardiovascular system.	SA	A	D	SD
19.	I am fatigued by exercise.	SA	A	D	SD
20.	I have improved feelings of well being from exercise.	SA	A	D	SD
21.	My spouse (or significant other) does not encourage exercising.	SA	A	D	SD

(Continued on reverse side)

		Strongly Agree	Agree	Disagree	Strongly Disagree
22.	Exercise increases my stamina.	SA	A	D	SD
23.	Exercise improves my flexibility.	SA	A	D	SD
24.	Exercise takes too much time from family relationships.	SA	A	D	SD
25.	My disposition is improved with exercise.	SA	A	D	SD
26.	Exercising helps me sleep better at night.	SA	A	D	SD
27.	I will live longer if I exercise.	SA	A	D	SD
28.	I think people in exercise clothes look funny.	SA	A	D	SD
29.	Exercise helps me decrease fatigue.	SA	A	D	SD
30.	Exercising is a good way for me to meet new people.	SA	A	D	SD
31.	My physical endurance is improved by exercising.	SA	A	D	SD
32.	Exercising improves my self-concept.	SA	A	D	SD
33.	My family members do not encourage me to exercise.	SA	A	D	SD
34.	Exercising increases my mental alertness.	SA	A	D	SD
35.	Exercise allows me to carry out normal activities without becoming tired.	SA	A	D	SD
36.	Exercise improves the quality of my work.	SA	A	D	SD
37.	Exercise takes too much time from my family responsibilities.	SA	A	D	SD
38.	Exercise is good entertainment for me.	SA	A	D	SD
39.	Exercising increases my acceptance by others.	SA	A	D	SD
40.	Exercise is hard work for me.	SA	A	D	SD
41.	Exercise improves overall body functioning for me.	SA	A	D	SD
42.	There are too few places for me to exercise.	SA	A	D	SD
43.	Exercise improves the way my body looks.	SA	A	D	SD