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Effects of a DVD-delivered exercise program on patterns of sedentary behavior in older adults: a randomized controlled trial☆,☆☆

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ABSTRACT

Introduction. In the present study, we examined the influence of a home-based, DVD-delivered exercise intervention on daily sedentary time and breaks in sedentary time in older adults.

Methods. Between 2010 and 2012, older adults (i.e., aged 65 or older) residing in Illinois ($N = 307$) were randomized into a 6-month home-based, DVD-delivered exercise program (i.e., *FlexToBa*; FTB) or a waitlist control. Participants completed measurements prior to the first week (baseline), following the intervention period (month 6), and after a 6 month no-contact follow-up (month 12). Sedentary behavior was measured objectively using accelerometers for 7 consecutive days at each time point. Differences in daily sedentary time and breaks between groups and across the three time points were examined using mixed-factor analysis of variance (mixed ANOVA) and analysis of covariance (ANCOVA).

Results. Mixed ANOVA models revealed that daily minutes of sedentary time did not differ by group or time. The FTB condition, however, demonstrated a greater number of daily breaks in sedentary time relative to the control condition ($p = .02$). ANCOVA models revealed a non-significant effect favoring FTB at month 6, and a significant difference between groups at month 12 ($p = .02$).

Conclusions. While overall sedentary time did not differ between groups, the DVD-delivered exercise intervention was effective for maintaining a greater number of breaks when compared with the control condition. Given the accumulating evidence emphasizing the importance of breaking up sedentary time, these findings have important implications for the design of future health behavior interventions.

1. Introduction

Adults in the United States are remarkably inactive: Less than half meet the minimum level of physical activity necessary to maintain health, and as few as 16% of older adults (i.e., 65 years of age or older) (Centers for Disease Control and Prevention (CDC), 2015) meet these recommendations (Centers for Disease Control and Prevention (CDC), 2014). This is particularly troubling given the well-established associations between physical inactivity and morbidity. Those who are insufficiently active are at increased risk for obesity, type 2 diabetes, several types of cancer, osteoporosis, and poor psychological health (Warburton et al., 2006). The World Health Organization estimates that 3.2 million deaths per year can be attributed to inactivity, as can nearly 700,000 premature deaths (World Health Organization, 2010). These high rates of inactivity are driven in large part by advances in leisure and occupational technologies within the last century (e.g., widespread use of the automobile; the prevalent use of internet and television) that prioritize efficiency while disincentivizing physical effort (Dunstan et al., 2012a).

These same technologies promote high levels of sedentary behavior even among those who meet or exceed recommendations for moderate to vigorous physical activity (MVPA). For example, a highly-active individual with a sedentary occupation might sleep for 8 h and exercise for 90 min in the morning, leaving 14.5 h each day to sit while commuting, working, and watching television or using the computer. Sedentary behaviors are often characterized by their posture (i.e., sitting, reclining) and by low levels of energy expenditure (i.e., ≤1.5 METs) (Dunstan et al., 2012a; Owen et al., 2011). Interestingly, emerging evidence suggests that daily sedentary time, and specifically the presence of long and unbroken bouts of sedentary time that typically characterize

Abbreviations: FTB, *FlexToBa*; MVPA, Moderate-to-vigorous physical activity; ANOVA, Analysis of variance; ANCOVA, Analysis of covariance.

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many occupational and leisure pursuits, is associated with morbidity (e.g., type 2 diabetes, cardiovascular disease) and mortality (Dunstan et al., 2012a, b; Healy et al., 2008a, b, 2011; Owen et al., 2010). Numerous observational studies suggest these effects are independent of time spent in MVPA. In a sample of 240,819 adults in the United States, Matthews et al. (2012) noted a graded elevation in risk for all-cause mortality with increased time spent watching television, a common form of sedentary behavior. The researchers further examined the role of MVPA for mitigating the mortality risk associated with sitting time, finding that even among individuals meeting or exceeding recommendations for MVPA, large amounts of television viewing were associated with a 1.5 to 2-fold increase in risk for all-cause mortality. A number of studies have also highlighted the importance of the manner in which sedentary time is accumulated (Healy et al., 2008b; Dunstan et al., 2012b). Healy et al. (2008b) examined the influence of breaks in sedentary time on markers of metabolic risk in a sample of 168 adults. The researchers found short, light intensity breaks to be beneficially associated with a number of metabolic markers (i.e., waist circumference, body mass index, triglycerides, 2-h plasma glucose), and these effects were independent of time spent in MVPA and total sedentary time. Findings such as these highlight the importance of reducing and breaking up sedentary time in addition to traditional approaches that focus on increasing time spent in MVPA. Increasing the amount of time spent in light intensity activities (i.e., 1.5–3.0 METs) is one strategy for accomplishing this goal, as these activities represent the primary determinant of daily energy expenditure (Donahoo et al., 2004) and are most likely to be replaced by sedentary behaviors (Dunstan et al., 2012a).

The recent focus on the importance of sedentary time reduction has led to a rapid growth in interventions targeting sedentary behavior. Early intervention work often focused on reducing time spent watching television. For instance, Otten et al. (2009) targeted television viewing in overweight and obese adults. The researchers restricted those in the intervention condition to 50% of their typical television viewing time, utilizing a device to power off the television once this limit is reached. When compared to a control condition, these individuals significantly decreased television viewing time, and this was met with a significant increase in energy expenditure and decrease in accelerometer-measured sedentary time. More recent work has directly targeted sitting in occupational and home contexts, often employing individualized counseling and/or brief prompts to cue individuals to stand. Healy et al. Healy et al. (2013) implemented a multilevel approach to reduce sitting time in office workers by targeting individual, environmental, and organizational elements of the workplace via individualized counseling, sit-stand work stations, and group workshops, respectively. Those randomly assigned to the intervention condition decreased time spent sitting by more than 2 h per day. Outside of the workplace, other researchers have utilized the recent proliferation of smartphones to provide cues to stand throughout the day. Over the course of a three-week feasibility study, Bond et al. (2014) distributed a smartphone application that delivered prompts to stand following three different durations of sedentary time (i.e., 30, 60, and 120 sedentary minutes). Individuals were assigned to each of the three groups in a counterbalanced order, and decreases in sedentary time were reported across all conditions.

This small body of research demonstrates that sedentary time and breaks in sedentary time are important health behaviors that are amenable to change. Still, many interventions that have targeted sedentary behaviors have been relatively brief in duration and would be difficult to deliver broadly (e.g., those with one-on-one counseling), limiting access for those of greatest need but who are unable to travel to a counseling session, such as older adults or those living in rural areas (Dunstan et al., 2012a; Owen et al., 2011; Clark et al., 2010). Designs that have taken advantage of technology to allow for broader delivery, such as those implementing smartphone-based prompting, may not provide sufficient support for long-term behavior change (Dennison et al., 2013). Finally, although older adults engage in the greatest proportion of sedentary time (Matthews et al., 2008, 2012), few interventions have directly targeted this population.

Recent reports describing a theory-driven, DVD-delivered, home-based exercise intervention for older adults (i.e., the *FlexToBa* program, hereafter referred to as FTB) (McAuley et al., 2012, 2013; Gothe et al., 2014; Fanning et al., 2015; Wójcicki et al., 2014) have demonstrated that such an approach holds promise for changing health behaviors among older adults. Though the program was designed to improve physical function by targeting elements of flexibility, strength, and balance, it produced improvements in accelerometer-measured MVPA (Gothe et al., 2014), and these effects were maintained across an extended no-contact period (Fanning et al., 2015) (see McAuley et al., 2012; Gothe et al., 2014) for detailed physical function and physical activity outcomes). Indeed, there are a number of features of the FTB program that indicate it may be an effective vehicle for influencing sedentary behaviors in older adults. It was delivered in the home via the television, a device which accounts for the greatest amount of time spent in leisure-time sedentary activity (Bureau of Labor Statistics, 2015). Exercise logs were placed in a visible location as a visual cue for activity in the home. Finally, each participant received a handbook outlining the progression of the program, discussing safe exercise, and providing tips for engaging in additional activity throughout the day, many of which focused on replacing sedentary behaviors with light activities (e.g., stand or ride a stationary cycling while watching television).

Accordingly, the purpose of this study is to examine whether a theory-based, DVD-delivered exercise program yields improvements in sedentary time outcomes in older adults, and whether these improvements are maintained over a six month, no-contact follow-up period. We hypothesized that those who received a DVD-based exercise program would report less daily sedentary time and more daily breaks in sedentary time at month 6. Additionally, given that those in the intervention condition retained the DVD and handbook across a no-contact follow-up period, we further hypothesized that these effects would be maintained at month 12.

2. Methods

2.1. Study design and interventions

The full study procedures, including the CONSORT diagram, are provided elsewhere (McAuley et al., 2012, 2013). Briefly, between 2010 and 2012, low active (i.e., ≤2 days per week of physical activity lasting greater than 30 min or more over the last six months), community dwelling older adults ($N = 307$) were recruited from a broad geographic region of central Illinois to participate in FTB, a six-month, DVD-delivered exercise program targeting flexibility, toning, and balance. Eligible participants were randomly assigned to the exercise intervention condition or to a waitlist control. Those in the intervention condition received an introduction DVD containing important information about safe exercise in addition to other healthy living information (e.g., replacing sitting behaviors, eating healthfully). These participants also received six DVD-based exercise sessions. Each session was designed to be used every other day for one month, and each one increased in complexity and difficulty relative to previous sessions. In addition to the DVDs, each participant received a yoga mat and two exercise bands of varying resistance. Exercise binders containing exercise logs and goal-setting worksheets were also provided. Participants completed exercise logs each day and mailed them on a monthly basis to the research staff, and data from these logs were used to provide individualized feedback. Participants were encouraged to place materials in a visible location as a cue to complete logs and engage in the program. Those in the control condition received the commercially available “Healthy Aging DVD” by Dr. Andrew Weil, which covers a variety of age-appropriate health topics. Following the month 12 assessment, control individuals