Title: Effects of a chronic physical activity program on accelerometry-based sedentary time in older adults participating in the LIFE study.

Research questions:

Question 1: Compared to a health education program, how does a 2-year structured physical activity program modify total sedentary time and bouts of sedentary time in mobility limited older adults?

Hypothesis: Older adults randomized to the physical activity program will experience a decrease in sedentary time and will spend shorter bouts being sedentary when compared to counterparts engaged in a health education program.

Question 2: Is the change in sedentary time (either total time or bout changes) associated with change in physical function in mobility limited older adults?

Hypothesis: Increases in both total sedentary time and bouts of sedentary time will be associated with declining physical function in older adults enrolled in the LIFE study.

Brief introduction:

Rising levels of sedentary activity among older Americans have emerged as a national public health concern[1]. This type of sitting-like activity has been linked to many adverse health outcomes including diabetes, cardiovascular disease and metabolic syndrome[2-4]. Coupled with aging effects, increased risk of these comorbidities can affect independence later in life[5,6]. Though physical activity has been shown to combat these risks[7], extant literature suggests that the effects of sedentary activity are independent of engaging in a structured physical activity program[8,9]. However, when older adults are introduced to a physical activity regiment, it is not clear whether sedentary activity is changed in the process. This reveals a gap in the knowledge to the magnitude and directionality among changes in sedentary activity when individuals engage in a structured physical activity intervention. To address this gap, this study first aims to longitudinally assess how objectively measured sedentary activity changes with a structured physical activity intervention compared with a health education program. Second, we will examine whether there is a shift in how sedentary time is accumulated following randomization to a physical activity or health education program among older adults participating in the LIFE study.

Outcomes to be used or calculated from raw accelerometry data:

- Daily sedentary time (assessed with accelerometry at baseline, 6 mo, 12 mo, and 24 mo)
- A bout of sedentary behavior will be defined as consecutive minutes in which the accelerometer registered less than 100 counts per minute. Sedentary bouts will be calculated two ways.
    - Number of bouts >1, ≥10 min, and ≥30 min
    - Time accumulated with each bout category
- The bout data will also be summarized into a single measure to describe the data. We will determine the bout length where 50% of the total sedentary time is accumulated (i.e., the minimum X such that ≥50% of the total sedentary time is accumulated in bouts <= X minutes)

- SPPB score and 400 meter walk speed
- Change scores will be calculated by subtracting the last follow-up value from the baseline value (FU-Baseline value)

Pre-processing and data reduction of sedentary bouts:
This analysis requires pre-processing of the raw accelerometry data. We will obtain the raw data from DMAQC and implement the methodology outlined by Shiroma and colleagues[10]. UF investigators have specific expertise processing raw accelerometry data using custom code developed in MatLab. The code to derive these results and the resultant summary bout data will be provided to DMAQC for their review and input.

Distribution of the sedentary bout data:
The distribution of the sedentary bout data will be evaluated prior to conducting analyses. In short, the number of bouts >1 min has a large range and is likely to be normally distributed. The number of bouts >10 and >30 are obviously truncated, but there remains sufficient variability. We will visualize the data and perform standard diagnostic tests to evaluate normality prior to running a specific parametric model. If normality is not retained then we will perform appropriate transformation. If that is not sufficient, then we will categorize the data into quantiles and perform a non-linear mixed model technique that are readily available in most statistics packages (e.g. nlmixed in STATA). The analyses proposed below assume that the data are normally distributed.

Primary analysis approach:
Sedentary time is defined as the amount of time in movement which is <100 cts/min captured through accelerometry. Daily sedentary time is available in baseline and follow-up datasets. Sedentary bouts are defined as spending pre-defined time intervals >1, ≥10 min, and ≥30 min in activity that is <100 cts/min.

Because there are concerns about balance between randomized groups due to missing baseline accelerometry data, Table 1 will report participant characteristics according to intervention and comparison groups. Descriptive statistics (t-test, chi squared, Wilcoxon, etc…) will be examined across treatment groups. Tables 2 and 3 will report the average sedentary time at baseline and follow up visits (6, 12, and 24 months) by intervention groups. Mean differences in sedentary time and bouts between intervention groups will be estimated using mixed effects (random and fixed) linear modeling, with the baseline value, follow-up visit (random effect), and an intervention by visit interaction included in the model. Factors used to stratify randomization (site and gender) will be included in the model. The follow-up visit will be considered the random effect in this model.

The association between the change in sedentary time and change in physical function will also be examined. For this analysis, the intervention groups will be collapsed to increase variability to detect associations and a simple linear regression analysis will be fitted against change scores. Both change in SPPB score and 400 meter walk speed will be examined. Partial R-square values will be reported as seen in Table 4. Prior to performing this analysis, we will visually examine potential non-linearity in the relationship between sedentary time and physical function (e.g. quadratic) and perform appropriate

analysis to capture this if it exists. We will also explore the effect of the interventions on this relationship. We will either adjust for intervention group or the total number of counts accumulated above 100 ct/min as a proxy of physical activity. We will explore these approaches in sensitivity analyses.

Missing data and Supplementary analyses:

There are missing accelerometry data at baseline. Approximately 300 people do not have valid accelerometry data at baseline. Therefore, only participants that have valid data at baseline will be included in this analysis (n ~ 1300). We can assume this data is missing at random, but there is a concern that it might not be random and there will be group differences at baseline. We will first examine differences in characteristics between participants with and without complete accelerometry data at baseline. If differences exist between the interventions groups as a result of missing data then we will explore adjusting for covariates (e.g. demographics, BMI etc…) to help equalize the groups.

We also expect to have missing data at follow-up visits. We will conduct supplementary analyses to examine potential differences in the results when only including participants with complete data (data on all measures) versus including participants with one or more missing values. Differences between the complete and non-complete data will result in discussions with DMAQC on appropriate modifications to the analysis.

We will perform supplementary analyses on participants to examine a potential modifying effect of having a low SPPB at baseline (low is defined as < 8). We will examine modification by including an intervention group by SPPB group interaction term in the model. A significant interaction ($P<0.1$) will result in stratified analyses.

Anticipated tables:

Table 1. Characteristics of participants by intervention group			
	Total (n =)	Physical activity intervention (n =)	Successful aging intervention (n =)
Age (mean, std)			
Female (n, %)			
College (n, %)			
Comorbidities >2 (n, etc)			
SPPB score			
400 meter walk speed			
Total sedentary time (mean, std)			
Number of bouts >1,			
Number of bouts ≥10 min,			
Number of bouts ≥30 min			
Bout length that represents 50% of the total time accumulated as sedentary			
Light activity (mean, std)			
Moderate activity (mean, std)			
Vigorous activity (mean, std)			
Etc….			

Table 2. Average total sedentary time by intervention group and follow-up visit			
	Total	PA	SA
	Average sedentary minutes (mean, std)		
6 months			
12 months			
24 months			

Analyses will use either mixed models or generalized linear mixed models, as appropriate for the outcome being studies. For example, we expect to use a Poisson model for count data, possibly with zero inflation. Models include baseline value, follow-up visit (random effect), and an intervention by visit interaction

Table 3. Average number of sedentary bouts by intervention group and follow-up visit			
	Total	PA	SA
	>1 minute sedentary bouts		
6 months	(mean, std)		
12 months			
24 months			
	≥10 minute sedentary bouts		
6 months	(mean, std)		
12 months			
24 months			
	≥30 minute sedentary bouts		
6 months	(mean, std)		
12 months			
24 months			
	Bout length that represents 50% of the total time accumulated as sedentary		
6 months	(mean, std)		
12 months			
24 months			

Analyses will use either mixed models or generalized linear mixed models, as appropriate for the outcome being studies. For example, we expect to use a Poisson model for count data, possibly with zero inflation. Models include baseline value, follow-up visit (random effect), and an intervention by visit interaction

Table 4. Sedentary characteristic changes in relation to change in measures of physical function		
	Change in SPPB score	Change in 400 meter walk speed
Change in total sedentary time	Partial R2 value from regression model	
Change in number of sedentary bouts >1 minute		
Change in number of sedentary bouts >10 minute		
Change in number of sedentary bouts >30 minute		
Changes in bout length that represents 50% of the total time accumulated as sedentary		

Change values are calculated by subtracting the last time of follow-up measure from baseline value (FU – Baseline value). Regression is used to evaluate the association between changes in sedentary time and changes in physical function.

Timeline:

4 months for data analysis and interpretation. An additional 4 months needed to write the manuscript. Estimated 8-10 months until publication

Target journals:

American Journal of Public Health, Journal of Aging & Physical activity, Medicine and Science in Sports and Exercise, Journal of Sports Sciences

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