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# Effects of Hearing Intervention on Physical Activity Measured by Accelerometry: a secondary analysis of the ACHIEVE Study

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CONFLICT OF INTEREST
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## Abstract

**Background:** Hearing loss is prevalent in older adults and associated with reduced daily physical activity, but whether hearing intervention attenuates declines in physical activity is unknown. We investigated the 3-year effect of a hearing intervention versus a health education control on accelerometer-measured physical activity in older adults with hearing loss.

**Methods:** This secondary analysis of the ACHIEVE randomized controlled trial included 977 adults aged 70–84 years with hearing loss. Participants were randomized to either a hearing intervention group or a health education control group. Physical activity was measured using wrist-worn accelerometers at baseline, 1, 2, and 3 years. Linear mixed models assessed the impact of the intervention on changes in total activity counts, active minutes per day, and activity fragmentation.

**Results:** Among 847 participants in the final analysis (mean age 76.2 years; 440 [52%] women; 87 [10%] Black; 5 [0.8%] Hispanic), total activity counts declined by 2.7% annually and active minutes/day declined by 2.1% annually over 3-years in both intervention and control groups. Activity patterns also became more fragmented over time. No appreciable differences were observed between hearing intervention and health education control in 3-year change in accelerometry-measured physical activity measures.

**Conclusions:** Hearing intervention did not appreciably attenuate 3-year declines in physical activity compared to health education control in older adults with hearing loss. Alternative strategies beyond hearing treatment may be needed to enhance physical activity among older adults with hearing loss.

### Keywords

hearing loss; physical activity; hearing aids

## Introduction

Older adults experience a 1–3% yearly decline in physical activity, which may hasten deficits in health and functioning.[1–3] Hearing loss is widespread in older adults, and associated with lower levels of physical activity, physical functioning, and mobility.[4–8] Potential mechanisms linking hearing loss with lower mobility and physical activity include increased cognitive load, less awareness of the surrounding environment, decreased social engagement, and higher disease burden.[5,6,9–11] However, whether hearing loss treatment can reduce or attenuate declines in physical activity is unknown.

Much of the research on hearing loss and physical activity has relied on self-reported measures of time spent in various activities, which may not adequately capture subtle but important changes in daily physical activity engagement and may be biased by problems with recall, particularly among older adults.[6,12–14] Objectively measuring physical activity with accelerometers provides the opportunity to capture quantities and patterns of daily physical activity in greater detail than questionnaires, but the use of accelerometers in older adults with hearing loss has been limited.[13] Gispen and colleagues examined the association between hearing loss and accelerometer-derived physical activity in adults aged 70+ years participating in the National Health and Nutrition Examination Survey (NHANES) but focused solely on time spent in moderate-to-vigorous activities (MVPA) per week.[7] Although useful for assessing compliance with physical activity guidelines, MVPA has otherwise limited utility in older adults, as it mostly captures engagement in routine exercise, is not scaled relative to functional ability and/or aerobic capacity, which vary widely in older adults, and fails to capture time spent in lighter intensity activities, which is the predominant type of daily activity for older adults.[1,12,15] To truly understand incremental, but important, changes in physical activity over time in older study populations, more detailed assessments of daily physical activity amount and patterns are warranted.[12,16,17] Moreover, past research has been observational, and interventional evidence is lacking.

The ACHIEVE study was a randomized controlled trial designed to test the effect of a hearing intervention versus a health education control on three-year cognitive decline in adults aged 70–84 years with untreated hearing loss.[18] The purpose of this analysis was to conduct a prespecified secondary data analysis of the effect of the hearing intervention, versus the health education control, on accelerometry measured physical activity quantities, patterns, and trends. The rationale for including objective physical activity in ACHIEVE stemmed from the hypothesis that the hearing intervention may enhance social engagement and increase awareness of -or comfort with- surroundings, thus increasing daily physical activity or attenuating aging-related declines.

# Methods

## Study design and participants

The ACHIEVE study was a 3-year, multicenter, randomized controlled trial in older adults with hearing loss (ClinicalTrials.gov: NCT03243422). ACHIEVE was partially nested within the Atherosclerosis Risk in Communities (ARIC) study, an ongoing observational study of heart disease, stroke, cognitive decline, and dementia. ARIC recruited adults aged 45–64 years (N=15,792) in 1987–1989 through four U.S. field sites (Forsyth County, NC; Jackson, MS; Minneapolis, MN; Washington County, MD).[19,20] ACHIEVE participants (n=977) were recruited through these field sites using both existing ARIC study participants (n=238) and de novo community-dwelling healthy volunteers (n=739). Inclusion criteria were: aged 70 –84 years, adult-onset bilateral mild-to-moderate hearing loss (better-ear 4-frequency (0.5 – 4 kHz) pure tone average (PTA) ≥30 decibel hearing level (dB HL) and < 70 dB HL), no substantial cognitive impairment (Mini-Mental State Exam [MMSE] score ≥ 23 for participants with a high school degree or less, ≥25 for participants with some college education or more), word recognition score in quiet ≥60% correct in the better-hearing ear, and fluent English speaking. Exclusion criteria were: self-reported disability in two or more activities of daily living, presenting visual acuity worse than 20/63 on the MNREAD acuity chart (Precision Vision, Woodstock, IL), reported hearing aid use in the past year, permanent bilateral conductive hearing loss, medical contraindication to hearing aid use, or unwillingness to wear hearing aids on a regular basis.[19] More details about the basic audiological characteristics of the cohort have been published elsewhere.[21]

The ACHIEVE trial was approved by the institutional review boards of all participating study sites and academic centers. Participants provided written informed consent.

## Hearing intervention procedures

Participants were randomly assigned (1:1) to either hearing intervention or health education control at baseline (2018–2019). Randomization was stratified by severity of hearing loss (PTA < 40 dB or ≥40 dB), recruitment source (ARIC vs. de novo), and field site. Intervention assignment was unmasked to participants and study staff, as participant hearing aid use is not feasibly blinded. Participants were blinded to the primary study hypothesis of attenuated cognitive decline and only informed that both interventions could promote healthy aging. Participants were told they would receive the intervention to which they were not assigned after the 3-year follow-up visit. Detail on the trial's study design and methods have been published elsewhere.[19]

The hearing intervention consisted of four one-hour sessions with an audiologist every 1-to-3 weeks post-randomization. Participants received bilateral hearing aids fit to prescriptive targets using real-ear measures. The intervention included education on using the hearing aids, as well as counseling on self-management and communication strategies. Booster sessions every 6 months provided re-instruction for device use and strategies. Further details on the hearing intervention have been previously published.[21,22]

The health education control consisted of four one-hour sessions with a certified health educator every 1-to-3 weeks post-randomization to match the level of participant time and attention in the hearing intervention arm. The health education control was based on the 10 Keys to Healthy Aging program,[19,23] an evidence-based interactive health education program for adults aged 65+ years on topics relevant to chronic disease and disability prevention. Sessions were customized to each participant and included didactic education/activities, goal setting, and a 5- to 10-minute upper extremity stretching program. Participants attended a booster session every six months.

## Physical activity assessment

Physical activity was assessed at baseline, 1-, 2- and 3-years using an ActiGraph GT9X tri-xial wrist-worn physical activity monitor (ActiGraph LLC, Pensacola, FL). At each clinic visit, participants were given the accelerometer and asked to wear the device continuously for seven days, removing it only for periods of swimming or bathing lasting longer than 30 minutes. After seven days, participants returned the device to the field site via pre-addressed, pre-paid mailers. Participants who reported using a walker for ambulation were excluded from the accelerometry portion of the study to attenuate measurement error.[12] Data were downloaded from the devices and transferred to the accelerometry reading center at the Johns Hopkins Center on Aging and Health. Raw data were converted to minute-level epochs, and periods of ≥90 minutes of consecutive zero-value observations were labeled as missing due to non-wear.[24] Days with >144 minutes missing (10% of the day) were removed.[25] A minimum of three valid days was required for inclusion in the analysis.[12,25] For periods of missing data on valid days, the average activity counts observed in the same period across other valid days were imputed.[26] Participants were followed every 6-months post-randomization. From March 2020 to June 2021, all study sites were closed for in-person study visits due to the COVID-19 pandemic. During this period, phone-based intervention and assessment of study outcomes was conducted and accelerometers were not distributed, resulting in some missing data at the 1- and 2- year time points.[18,19]

## Physical activity outcomes

Total daily activity volume and intensity were assessed using total activity counts per day (TAC), defined as the sum of activity counts on valid days divided by the number of valid days.[26] An activity count is a unit of movement summarized across the three axes of the accelerometer. Higher activity counts indicate more activity over a given time, in both amount and intensity of movement. An active state was defined as activity counts ≥1853 counts/minute, and a non-active state was defined as activity counts <1853 counts/minute.[25,27] Active minutes/day was defined as the number of minutes where activity counts exceeded 1853 counts/minute each day, averaged across valid days.[25]

A measure of activity fragmentation, the active-to-sedentary transition probability (ASTP), was calculated by quantifying each participant's active and sedentary time on a minute-by-minute basis for each valid day.[16] Bout length was defined as the number of consecutive minutes spent in either an active or a sedentary state, and a daily activity profile was created for each participant to detect alternating bouts of sedentary and active states. ASTP was defined as the probability of transitioning from an active state to a sedentary state in the next minute, calculated as the reciprocal of the average active bout duration, and expressed as a percentage.[16] ASTP was averaged across valid days to derive a single index of activity fragmentation for each participant, with higher scores indicating that active bouts are more fragmented or "broken up" throughout the day. Previous work suggests activity fragmentation is often more strongly associated with aging-related health outcomes than traditional physical activity measures.[12,15–17]

## Covariates

Covariates measured at baseline include age, sex (male, female), education (elementary or some high school; high school or equivalent or some college; Bachelor's degree or greater), and recruitment source (ARIC, de novo cohorts). Spousal pairs were always randomized as a group given that they could not be statistically treated as non-correlated individuals given shared experiences, living environment, etc. Including them as a covariate was to account for any imbalance in spousal pairs across the two intervention arms.

## Statistical analysis

Accelerometry-measured physical activity was a pre-specified, exploratory outcome of ACHIEVE, and analyses were considered hypothesis-generating rather than hypothesis-testing. Thus, we focus on the patterns of effect across outcomes instead of evaluating statistical significance. P-values are provided for descriptive purposes.

Baseline participant characteristics were examined overall and by randomization assignment. The effect of randomly assigned treatment on 3-year change in each physical activity outcome was estimated using a two-level linear mixed effects model under the intention-to-treat principle. Each model examined repeated assessments (level one) nested within participants (level two) and used an unstructured covariance matrix and restricted maximum likelihood with a Kenward-Roger correction. A random intercept and time slope were specified at level two to permit subject-specific variability in change over time. A continuous time from baseline variable and an interaction between time and randomization assignment were included in the model. The model was adjusted for prespecified covariates of age, sex, education, field site, and recruitment source. The complier average causal effect (CACE) was also estimated by applying inverse-probability weights derived from a logistic regression model of compliance in participants assigned to hearing intervention.

Function-on-scalar regression (FOSR) models were used to examine whether there were intervention differences in 3-year change in diurnal physical activity by the mean of log activity counts in 30-minute bins, adjusted for age, sex, education, field site, and recruitment source. FOSR models the association of the mean of log activity counts in each 30-minute bin and intervention assignment; enforcing the smoothness of the intercept and coefficients of all independent variables over time of day, and estimating the intervention difference as a function of time of day, which may highlight important differences in daily activity patterns.[25,28] The activity counts were logged to reduce the heteroscedasticity of the data and facilitate the estimate of functional fixed effects while accounting for within-function and within-subject correlations.

Three separate sensitivity analyses were conducted. The first limited data to only baseline and 3-year follow-up to avoid years impacted by COVID-19 (Table S2). Second, we added a time indicator variable of COVID-19 pandemic to the main model where 0 represented assessments occurring before or on March 14, 2020, and 1 represented assessments occurring after June 30, 2021 (Table S3). Third, we repeated the main analysis looking at ARIC and de novo participants separately (Tables S4 and S5).

All analyses were completed in Stata (version 18.0), with the exception of FOSR models, which were performed using the "bayes_fosr()" from the "refund" package (https://cran.rproject.org/web/packages/refund) in R (version, 4.0.5, www.r-project.org).

## Results

### Study population

Of the 977 participants randomized, 888 (91%; 50% assigned to hearing intervention) had longitudinal accelerometry (2,263 observations across baseline and follow-up). Of the 2,263 observations, 2,205 observations (97%) were defined as a "valid accelerometry day." Of the 888 participants, 847 (95%; 50% assigned to hearing intervention) participants who had ≥3 valid wear days at baseline were included in the final longitudinal analytic sample. Table S1 details the differences between those included and excluded. Those excluded were slightly older and were more likely to be women, Black, and recruited from within the ARIC study than those who were included. They were also more likely to have a history of hypertension.

Table 1 shows the baseline characteristics overall and by intervention assignment. The overall study population had a median age of 76.2 years, of which 52% were women, and 10% were Black. The most common chronic conditions were hypertension (65%), high cholesterol (60%), arthritis (55%) and diabetes (20%). All other conditions were relatively rare, with a prevalence ≤15%. Participants were well functioning, with a mean Short Physical Performance Battery score of 10 (SD=3; range 1–12). Hours of hearing aid use per day have been previously reported.[6] Briefly, Participants receiving the hearing intervention reported a mean of 7.2 h (SD 5.2) of hearing aid use per day at year 3.

Table 2 shows descriptive physical activity metrics overall and by intervention assignment at baseline and Year 3. At baseline, total daily activity counts averaged 1,863,943 (SD=810,889) counts/day, with 382.3 (SD=160.5) minutes of daily active time and an activity fragmentation index of 23.8% (SD=8.2%). On average, total daily activity (counts/day and active minutes/day) decreased -2.7% and -2.1% per year, respectively, and became more fragmented (1.2% per year).

Participants averaged 7 (SD=1) valid accelerometer wear days and wore the device an average of 1439.9 (SD=0.1) minutes/day (99.9% of the day).

### Association between intervention assignment and physical activity

The results of the linear mixed models for the hearing intervention versus the health education control are shown in Table 3. Predictive margins for all models are shown in Figure 1. There was no effect of the hearing intervention on any of the physical activity outcomes as indicated by the intervention*time interaction term (Table 3). The CACE analysis showed similar results to the intention-to-treat models (Supplementary Table S1). The FOSR time-of-day analyses did not show any group differences by intervention (Figure 2). Sensitivity analyses also did not suggest any consistent differences by intervention status (Supplementary Tables S2–S5).

## Discussion

Among older adults with hearing loss, physical activity declined over three years of follow-up, and did not appreciably differ by intervention status. Results were unchanged in sensitivity analyses that examined ARIC and de novo participants separately and accounted for the effects of the COVID-19 pandemic. These results suggest that hearing intervention versus health education control does not substantively affect trajectories of physical activity in older adults with hearing loss within three years, and that alternative strategies are needed to enhance daily physical activity.

Interest in the association between hearing loss and physical activity has grown over the past decade due to increased awareness of hearing loss in older adults[4,29] and its potential detrimental effects on physical functioning.[5] Novel metrics of physical activity patterns and intensity, such as activity fragmentation and diurnal patterns of physical activity, have been linked with measures of physical function, mortality, and cognitive health, over and above traditional measures of daily physical activity.[3,12,16,17,26] Kuo and colleagues found that poorer hearing was associated with more fragmented physical activity patterns among adults aged 60–69 in the 2003–2004 round of NHANES. More recently, analyses from the 2021 round of the National Health and Aging Trends Study, demonstrated that adults aged 70+ with moderate-or-greater hearing loss had lower daily activity that was accumulated in more fragmented patterns compared to those with normal hearing.[6,16] Further, this association was stronger among older adults who did not use hearing aids, implying a potential beneficial impact of hearing aid use on daily physical activity in older adults with hearing loss.[6] Despite this collective evidence, the current results did not show a benefit for the hearing loss intervention compared to the health education control in attenuating physical activity declines.

Hearing loss has been linked with poorer balance performance and reduced endurance capacity, both of which may be negatively impacted by low and declining physical activity.[5,9] Conversely, poor balance and less awareness of surroundings may lead some older adults to reduce physical activity as a precautionary measure against falls. The lack of association of the ACHIEVE hearing intervention with physical activity may suggest that earlier intervention is needed to attenuate declines in physical activity that likely begin with the onset of hearing-loss pathology, before clinically relevant thresholds are detectable. Alternatively, it may take longer than three years to observe changes in long-term habits such as daily active and sedentary behaviors. Further, although hearing loss has been linked to greater social isolation and loneliness, increased social interaction resulting from a hearing intervention may not directly translate to increased physical activity.[30] Long-term follow-up of the ACHIEVE cohort is ongoing, and future analyses of physical activity will help address these research gaps.

Physical activity is a central component of functional independence and is essential to maintaining health and quality of life. In ACHIEVE, mean total activity counts/day averaged 1,863,943 at baseline and declined 2.7% annually. Active minutes/day averaged 382.3 minutes at baseline and declined 2.1% annually. This shift suggests a high proportion of the day ( ≥17 hours) was spent in sedentary behaviors or asleep. Moreover, the larger relative decline in activity counts (measure of intensity and frequency) versus active minutes (measure of frequency alone) suggests that a decrease in activity intensity may be the primary mechanism of decline. Although normative data for longitudinal changes in accelerometry-measured physical activity are not well-established, recent evidence from two large cohorts suggests an annual decline of 2–3% for adults aged 70+ years.[1,2] To this end, the 2.7% annual decline in physical activity in ACHIEVE participants is within the expected range. This may suggest that reductions in function and endurance performance previously noted in older adults with hearing loss[5,9] are not from accelerated losses of physical activity in later life, and may result from physiological mechanisms occurring earlier in the pathological process. More research is needed to disentangle the temporality and dose-response association between hearing loss and physical activity. Further, given the important role of physical activity in maintaining health and longevity, exploring other methods to enhance and maintain physical activity in older adults with hearing loss is warranted.

Strengths of the ACHIEVE trial include its enrollment of a large population of older adults with hearing loss, high adherence and follow-up rates, and rigorous assessment of physical activity using accelerometers. There are also limitations. First, because of the nature of the intervention, participants and study staff were not blinded. Second, there was no normal hearing control group, so we are unable to say how physical activity decline in those with hearing loss compares to those without hearing loss. Third, although physical activity was a prespecified outcome, it was not a primary or secondary outcome of the trial; however, it was rigorously assessed and participants had high compliance. Fourth, it is possible that participants randomized to the health education control group experienced less decline in physical activity than they would have if they had not been part of the intervention, thus attenuating potential differences between the intervention and control groups. Longer-term follow-up of participants beyond three years may enhance the ability to delineate these effects. Finally, the sample was limited to participants with fewer than two ADL disabilities, which may limit the generalizability of these results. This criterion was included to enhance internal validity and reduce the potential for increased risk of loss to follow-up among individuals with multiple impairments.

## Conclusion

We found no difference by hearing intervention versus health education control status on physical activity over three years of follow-up. To this end, the results of this study do not support the use of hearing aids to increase -or attenuate declines in- physical activity in older adults with hearing loss. More research is needed to understand the complex association of hearing loss with low or declining physical activity and its potential contribution to reduced physical functioning in older adults. Importantly, when combined with observational evidence highlighting poorer physical function and endurance capacity in older adults with hearing loss (compared to those with normal hearing), these results suggest that low and declining physical activity reflects a state of vulnerability that confers a higher risk of adverse health outcomes. Early screening and intervention efforts to reduce the risk of such adverse health effects in older adults with hearing loss are warranted.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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## Key Points

- Among 847 older adults with hearing loss, physical activity declined over 3-years.
- A hearing intervention did not appreciably attenuate 3-year declines in physical activity compared to health education control in older adults with hearing loss.
- Alternative strategies for increasing physical activity are needed to address physical function deficits in older adults with hearing loss.

**Why does this paper matter?**

Hearing intervention alone may be insufficient to enhance physical activity in older adults with hearing loss within three years; alternative strategies to increase physical activity and preserve mobility are needed.

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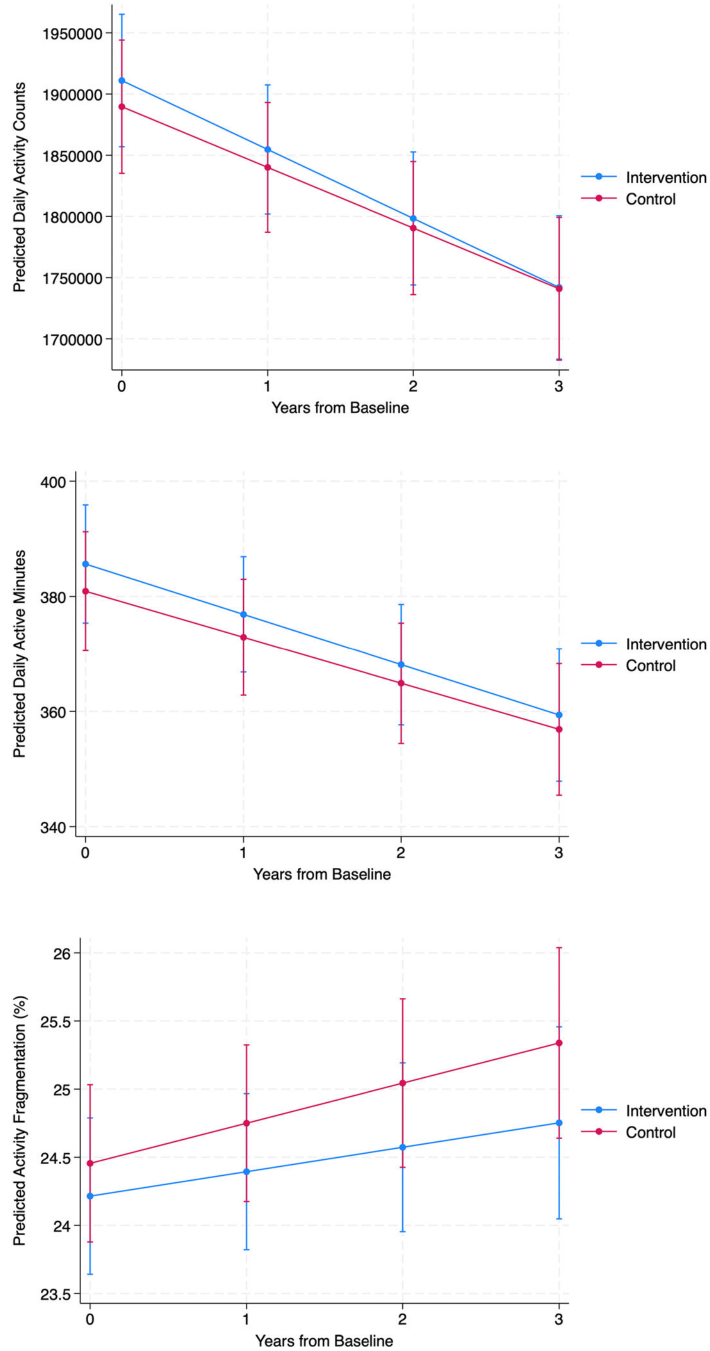


**Figure 1a.**

Covariate-Adjusted Predicted Daily Activity Counts by Intervention over Follow-Up

Note: Predicted daily activity counts for the intervention and control groups over the 3-year follow-up period, adjusted for age, sex, field site, education, and recruitment source. Data points represent the covariate-adjusted means, and error bars indicate 95% confidence intervals.

Figure 1b. Covariate-adjusted Predicted Daily Active Minutes by Intervention over Follow-Up

Note: Predicted daily active minutes for the intervention and the control groups over the 3-year follow-up period, adjusted for age, sex, field site, education, and recruitment source. Data points represent covariate-adjusted means and error bars indicate 95% confidence intervals.

Figure 1c. Covariate-Adjusted Predicted Activity Fragmentation (%) by Intervention over Follow-Up

Note: Predicted activity fragmentation (%) for the intervention and the control groups over the 3-year follow-up period, adjusted for age, sex, field site, education, and recruitment source. Data points represent covariate-adjusted means and error bars indicate 95% confidence intervals.

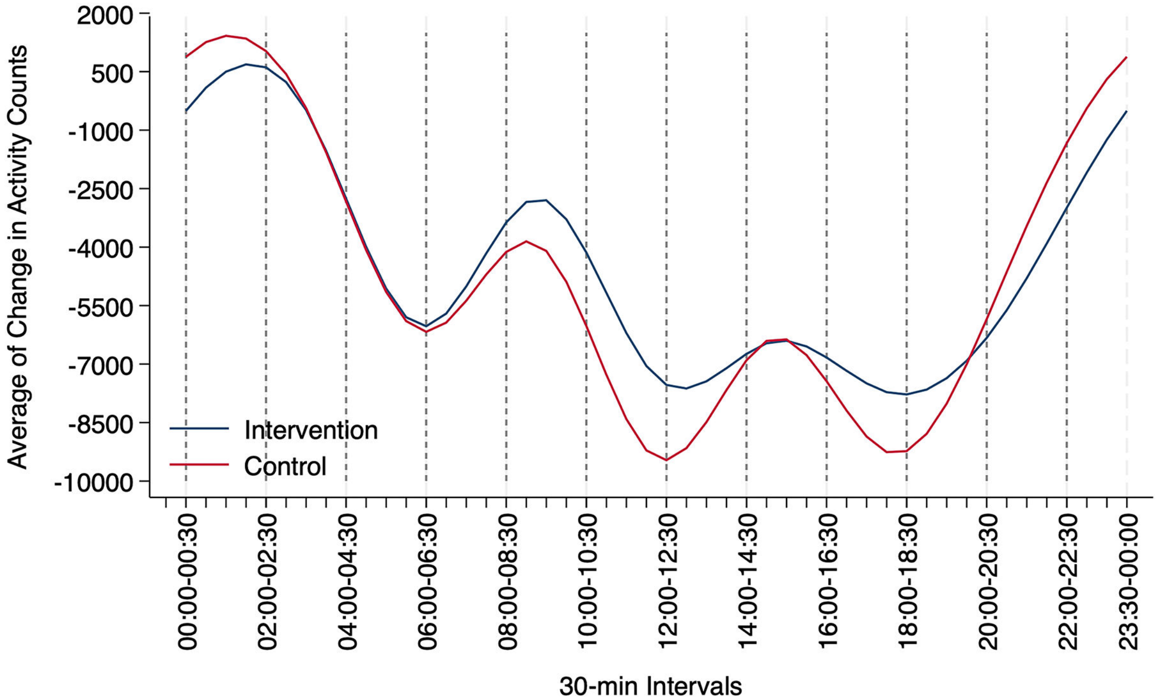


**Figure 2. Covariate-Adjusted Function-on-Scalar Regression Plot of Average Time-of-Day Differences by Intervention**

Covariate-adjusted average change in log activity counts per 30-minute interval across the 24-hour day for the intervention and the control groups. Covariates included in the model are age, sex, field site, education, and recruitment source.

**Table 1.**

Baseline Descriptive Characteristics by Intervention Assignment

| | Total n=847 | Intervention n=427 | Control n=420 |
|---|---|---|---|
| **Age (years), Median (IQR)** | 76.2 (6.2) | 75.7 (6.2) | 76.4 (6.3) |
| **Female, N (%)** | 440 (52) | 227 (53) | 213 (51) |
| **Black, N (%)** | 87 (10) | 43 (10) | 44 (10) |
| **Field Site, N (%)** | | | |
| Forsyth County, NC | 212 (25) | 106 (25) | 106 (25) |
| Jackson, MS | 203 (24) | 104 (24) | 99 (23) |
| Minneapolis, MN | 197 (23) | 98 (23) | 99 (23) |
| Washington County, MD | 235 (28) | 119 (28) | 116 (28) |
| **ARIC cohort, N (%)** | 188 (22) | 92 (21) | 96 (23) |
| **Income <$25,000, N (%)** | 119 (14) | 56 (13) | 63 (15) |
| **Bachelor's degree or higher, N (%)** | 451 (53) | 224 (52) | 227 (54) |
| **Married, N (%)** | 527 (62) | 258 (60) | 269 (64) |
| **Current smoker, N (%)** | 20 (2) | 14 (3) | 6 (1) |
| **BMI, Median (IQR), n=845** | 28.3 (6.7) | 28.3 (6.5) | 28.1 (6.9) |
| **SPPB, Median (IQR), n=843** [a] | 10 (3) | 10 (3) | 10 (3) |
| **Grip strength (kg), Median (IQR), n=839** | 28 (14) | 28 (14) | 28 (14) |
| **Chronic conditions, N (%)** | | | |
| Hypertension, n=844 | 547 (65) | 287 (67) | 260 (62) |
| Coronary heart disease, n=842 | 127 (15) | 67 (16) | 60 (14) |
| Stroke/TIA, n=842 | 67 (8) | 34 (8) | 33 (8) |
| High cholesterol, n=842 | 502 (60) | 250 (59) | 252 (61) |
| Diabetes | 166 (20) | 87 (20) | 79 (19) |
| Respiratory disease, n=846 | 70 (8) | 35 (8) | 35 (8) |
| Arthritis, n=845 | 469 (55) | 229 (54) | 240 (57) |
| Kidney disease, n=845 | 45 (5) | 20 (5) | 25 (6) |
| Depression score, Median (IQR) [b] | 2 (3) | 2 (3) | 2 (3) |

**Abbreviations:** ARIC, Atherosclerosis Risk in Communities, BMI, Body mass index (kg/m$^2$); SPPB, Short physical performance battery; TIA, Transient ischemic attack

[a] Higher SPPB score represents higher performance (0–12).

[b] Depression score is from Center for Epidemiologic Studies Depression 11-item scale (0–22) where higher scores indicate higher depressive symptoms.

**Table 2.**

Descriptive Physical Activity Patterns at Baseline and Year 3

| | Baseline | | | Year 3 | | |
|---|---|---|---|---|---|---|
| | **Total** | **Intervention** | **Control** | **Total** | **Intervention** | **Control** |
| ***Median (IQR)*** | **n=847** | **n=427** | **n=420** | **n=626** | **n=305** | **n=321** |
| **Valid wear days** | 7 (1) | 7 (1) | 7 (1) | 8 (1) | 8 (1) | 8 (1) |
| **Wear time/day (minutes)** | 1439.9 (0.1) | 1439.9 (0.1) | 1439.9 (0.1) | 1439.9 (0.1) | 1439.9 (0.1) | 1439.9 (0.1) |
| **Activity counts/day** | 1,863,943 (810,889) | 1,898,875 (848,723) | 1,838,344 (783,937) | 1,724,001 (804,394) | 1,732,098 (794,169) | 1,715,999 (794,225) |
| **Active minutes/day** | 382.3 (160.5) | 384.8 (163.4) | 377.5 (160.0) | 365.6 (156.0) | 367.3 (148.9) | 363.4 (161.9) |
| **Activity fragmentation (%)** | 23.8 (8.2) | 23.5 (8.6) | 23.9 (7.8) | 23.8 (8.5) | 23.8 (8.1) | 23.8 (8.9) |

**Table 3.**

Covariate-Adjusted Analysis of Annual Change of Each Physical Activity Pattern by Randomized Intervention Assignment (n=847)[a]

| | | 95% CI | |
|---|---|---|---|
| | **Beta** | **Lower** | **Upper** |
| | **Total activity counts/day** | | |
| **Intervention × Time** | −6,767.9 | −24,316.63 | 10,780.85 |
| **Intervention** | 21,391.14 | −55,353.35 | 98,135.63 |
| **Time** | −49,583.51 * | −61,873.35 | −37,293.67 |
| | **Active minutes/day** | | |
| **Intervention × Time** | −0.7 | −4.4 | 2.9 |
| **Intervention** | 4.7 | −9.8 | 19.3 |
| **Time** | −8.0 * | −10.6 | −5.4 |
| | **Physical activity fragmentation (%)** | | |
| **Intervention × Time** | −0.11 | −0.35 | 0.12 |
| **Intervention** | −0.24 | −1.05 | 0.57 |
| **Time** | 0.29 * | 0.13 | 0.46 |

[a]Mixed effects models adjusted for fixed effects of age, sex, field site, education, and recruitment source and treating time as a fixed and random effect.

*p<0.05