Activating Behavior to Reduce Sedentary Behavior After Stroke: A Nonrandomized Pilot Feasibility Study

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Importance: Reducing poststroke sedentary behavior is important for reducing recurrent stroke risk, yet interventions to achieve this are scant.

Objective: To assess the feasibility of, and estimate change in sedentary behavior over time associated with, a behavioral intervention.

Design: Single-arm delayed baseline with postintervention and 8-wk follow-up assessment.

Setting: Community based.

Participants: Ambulatory, community-dwelling people with chronic stroke and reported ≥6 hr daily sitting time (N = 21).

Intervention: Activating Behavior for Lasting Engagement (ABLE) was delivered by an occupational therapist 3×/wk for 4 wk. ABLE involves activity monitoring, activity scheduling, self-assessment, and collaborative problem solving.

Outcomes and Measures: Feasibility (participant safety, adherence, satisfaction, and reliable intervention delivery) was assessed against preestablished benchmarks. Changes over time in sedentary behavior (assessed with an ActivPAL micro3 device) and participation (Stroke Impact Scale–Participation subscale) were described.

Results: ABLE was safe (0 serious adverse events), adhered to (11.95 sessions/participant), and reliably delivered (90.00%–97.50% adherence). Participant satisfaction was unmet (Client Satisfaction Questionnaire–8, M = 28.75, SD = 3.84). ABLE was associated with a mean group reduction in prolonged sitting of 54.95 min (SD = 81.10) at postintervention and 14.08 (SD = 58.95) at follow-up. ABLE was associated with a negligible mean group increase over time in participation at postintervention (M = 1.48%, SD = 8.52) and follow-up (M = 1.33%, SD = 15.38).

Conclusions and Relevance: The ABLE intervention is feasible and may be associated with within-group reduction in sedentary behavior over time. Further refinement is indicated.

What This Article Adds: The ABLE intervention uses engagement in meaningful daily activities to reduce sedentary behavior after stroke. These findings suggest that ABLE can be delivered safely and consistently. Further research is required to enhance participant satisfaction and determine the effects of ABLE on stroke survivors' sedentary behavior.

Modifying recurrent stroke risk is critical to health (Pandian et al., 2018). Within 1 yr poststroke, an estimated 6%–11% of stroke survivors sustain a recurrent stroke (Benjamin et al., 2019). Within 10 yr, 25%–39% sustain a recurrent stroke (Benjamin et al., 2019). Approximately 74% of recurrent stroke incidence has been attributed to modifiable behavioral risk factors, including sedentary behavior (Benjamin et al., 2019). Poststroke guidelines provide clear recommendations for exercise and physical activity (Billinger et al., 2014); however, prolonged sedentary behavior persists, even among people who adhere to these recommendations (English et al., 2014).

Sedentary behavior is time awake spent in seated or reclined positions during activities that require no more than 1.5 times the resting metabolic energy expenditure (Tremblay et al., 2017). Stroke survivors spend more than 10 hr per day being sedentary (English et al., 2014). Accumulating these hours in unbroken stretches of time is particularly

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detrimental to health (Diaz et al., 2017). Breaking up prolonged stretches of sedentary time by routinely engaging in daily activities may be an achievable goal for people with stroke seeking to improve their health (Morton et al., 2019).

Two studies have explored interventions to reduce sedentary behavior. One study applied motivational interviewing during individual counseling sessions to encourage sitting less by engaging in meaningful activities (English et al., 2016). The other study applied social cognitive theory during in-home and remotely delivered telephone counseling sessions over 8 wk. Participants used a wearable prompting device and were encouraged to stand up at specified intervals (Ezeugwu & Manns, 2018). Both studies detected a range of small to large effects (Cohen's *d*) on sedentary behavior. We recently developed the Activating Behavior for Lasting Engagement (ABLE) intervention, which combines engagement in meaningful activities (English et al., 2016) and activity scheduling (Ezeugwu & Manns, 2018) using active ingredients guided by a behavioral activation framework.

Behavioral activation provides a structured approach for facilitating engagement in pleasurable activities (Kanter et al., 2010). This approach is effective in reducing depression symptoms among people with major depressive disorder, traumatic brain injury, and caregivers of people with dementia (Bradbury et al., 2008; Cuijpers et al., 2007; Moore et al., 2013). The ABLE intervention is an adaptation of behavioral activation that provides stroke survivors with a structured approach for scheduling and self-monitoring frequent engagement in activities as well as problem solving during those activities (Kringle et al., 2019). Aligned with best practices for piloting complex interventions (Moore et al., 2011), the goals of the current study were to assess the feasibility of ABLE for people with chronic stroke and describe change over time in sedentary behavior that may be associated with the ABLE intervention. We expected that ABLE would be feasible and associated with moderate to large effects (Cohen's $d \geq 0.51$) on sedentary behavior.

Method

A single-group study was conducted to examine the feasibility of ABLE. Feasibility was assessed against established benchmarks during the 4-wk intervention period. Sedentary behavior was assessed at four time points: Week 1, Week 6, Week 11, and Week 18. The intervention was delivered during Weeks 7–10. This delayed-baseline design allowed for assessment of the baseline stability of sedentary behavior. Study procedures were approved by the University of Pittsburgh institutional review board and conducted in compliance with the Helsinki Declaration. Participants provided informed consent.

Participants

Participants were recruited from the community (e.g., outpatient clinics, support groups) and previous stroke rehabilitation research studies at our institution. People who met the following criteria were included: ≥18 yr old; stroke diagnosis; between 6 mo and 5 yr poststroke; ambulatory, with or without an assistive device; ≥6 hr spent sitting per day (Sedentary Behavior Questionnaire; Rosenberg et al., 2010); and residence within 50 miles of our institution. The sitting (sedentary) criterion was based on mean sedentary time of healthy older adults (Harvey et al., 2015), which defines a population that is likely to derive health benefits from intervention (Aunger et al., 2018). People who met the following criteria were excluded: severe aphasia (Boston Diagnostic Aphasia Evaluation severity score ≤1; Borod et al., 1980); current participation in occupational, physical, or speech therapy; current cancer treatment; current major depressive, psychiatric, or substance abuse disorder (Patient Health Questionnaire–9 [PHQ–9; Kroenke et al., 2001]; PRIME–MD/Mini-International Neuropsychiatric Interview [Spitzer et al., 1994]); or diagnosed neurodegenerative disorder.

Intervention

Participants took part in 12 one-on-one sessions (3×/wk for 4 wk) delivered by two trained occupational therapists (Emily A. Kringle and a research assistant). In-home sessions were prioritized. To accommodate participants' schedules, laboratory or telephone sessions were permitted. Missed sessions were rescheduled. The first two sessions included sedentary behavior education, self-monitoring of sitting time, and completion of the Activity Card Sort (to generate a list of meaningful activities; Katz et al., 2003). During Session 2, participants selected an activity and scheduled specific times during which they intended to complete it. Participants monitored their activities between sessions. Each of the remaining sessions focused on a review of activity monitoring, self-assessment of successes and challenges, problem solving, and scheduling of future activities (active ingredients were described by Kringle et al., 2019). This iterative process was documented in a participant workbook.

Feasibility Measures

Reliability

Reliability of the intervention delivery was assessed through video review by an independent research assistant (Hildebrand et al., 2012). The first 2 sessions were reviewed to assess fidelity to the introductory processes. Two of the 10 remaining sessions (selected using a random numbers table) were reviewed to determine the presence or absence of active ingredients against fidelity checklists developed in our laboratory. The ABLE intervention was considered feasible if each active ingredient was present in 90% or more of sampled intervention sessions.

Acceptability

Acceptability was assessed with the Client Satisfaction Questionnaire–8 (CSQ–8; Attkisson & Greenfield, 2004), a valid and reliable instrument with eight questions that are rated on a 4-point Likert-type scale. Scores are summed (range = 8–32; high scores indicate high satisfaction). The CSQ–8 was completed during a postintervention telephone interview conducted by an independent assessor. The ABLE intervention was considered acceptable if the group mean was greater than or equal to 28.80.

Adherence

Participant adherence to the ABLE intervention schedule was assessed by documented session attendance. The duration and frequency of intervention sessions attended were calculated as descriptors of intervention intensity. Adherence was considered satisfactory if participants completed greater than or equal to 90% (10.80) of the intervention sessions.

Safety

The ABLE intervention poses a minimal risk of falls, but people with stroke experience more falls than members of healthy populations (Batchelor et al., 2012). We documented and discussed with participants adverse events (e.g., a fall that occurred during a scheduled activity) to determine whether they were related to ABLE. We expected that no serious (injurious) adverse events would occur during the study.

Clinical Measures

Clinical outcomes were administered by an independent assessor at Weeks 1, 6, 11, and 18. Descriptive characteristics were assessed at Week 1.

Descriptive Characteristics

Demographic and stroke characteristics were collected through participant interview and medical record review. We also described comorbidity severity (Self-Administered Comorbidity Index; Sangha et al., 2003), fatigue (PROMIS Fatigue Scale 8a; Cella et al., 2016), pain (Numeric Pain Rating Scale; Ferreira-Valente et al., 2011), mood (PHQ–9), cognitive function (NIH Toolbox; Weintraub et al., 2014), and mobility and function related to activities of daily living and instrumental activities of daily living (Stroke Impact Scale; Duncan et al., 2003).

Clinical Outcomes

Sedentary behavior was defined as daily minutes of prolonged sitting (accumulated in uninterrupted increments of ≥30 min). It was measured using the ActivPAL micro3 (PAL Technologies, Glasgow, Scotland), which demonstrates good validity and reliability among people with stroke (Edwardson et al., 2017). The device was waterproofed and adhered to the anterior part of each participant's unaffected thigh for 7 days, 24 hr per day, at each time point. During each day of wear, participants documented the times when they woke, got out of bed, went to bed, went to sleep, and slept during the daytime. They also documented device nonwear time. Data were retrieved from the device using ActivPAL3 software (Version 7.2.38; PAL Technologies, Glasgow, Scotland), and a diary-informed process was used to manually remove sleep and nonwear times (Barone Gibbs & Kline, 2018). Days were valid if the monitor had been worn during all waking hours. Time points with 4 or more valid days were included in analyses. The mean daily minutes of prolonged sitting were calculated for each time point. For analyses, prolonged sitting duration was adjusted to standardize within-person waking time over all time points.

Participation was measured using the Stroke Impact Scale–Participation subscale (SIS–P). The SIS–P is a valid and reliable measure in which participants report the degree to which they feel limited in activity domains (e.g., social activities, active participation). These scores were used to compute the percentage of participation in meaningful activities (Duncan et al., 2003).

Analyses

Feasibility outcomes were assessed against benchmarks. Distribution and patterns of missingness for clinical measures were examined. Stability of sedentary behavior and participation outcomes was assessed between Weeks 1 and 6. Outcomes with a coefficient of variation ≤10% were considered stable over time (Atkinson & Nevill, 1998). The mean of these outcomes at Week 1 and Week 6 was calculated and coded T0 (Time 0, baseline). Week 11 was coded T1 (Time 1, postintervention), and Week 18 was coded T2 (Time 2, follow-up). The direction and magnitude of individual and group change from T0 to T1 and from T0 to T2 were examined. A modified version of Cohen's d was used to calculate effect sizes that account for within-person repeated measures (Morris, 2008). Effect sizes were interpreted as follows: small, $d = 0.10$–0.50; moderate, $d = 0.51$–0.70; and large, $d > 0.71$(Cohen, 1988). Reduction of ≥60 min per day of prolonged sitting (Diaz et al., 2017) or an increase by ≥10% on the SIS–P was considered clinically meaningful (Fulk et al., 2010).

Results

Participants

Twenty-five people were screened, and 21 were enrolled. One participant was withdrawn during Baseline 2 (Week 6) because of noncompliance with activity monitoring. Two participants had missing sedentary behavior (ActivPAL) data at follow-up (one was hospitalized, and one had misplaced the ActivPAL device).

Demographic and descriptive characteristics are presented in Table 1. Participants were, on average, 70.81 yr old (SD = 10.92), and the majority (61.9%) were female. Participants were 29.38 mo (SD = 14.34) poststroke and had primarily sustained ischemic strokes (90.48%) affecting the left (57.14%), right (33.33%), or bilateral (9.52%) hemispheres.

Intervention Feasibility

Benchmarks for reliable intervention delivery, adherence to intervention schedule, and safety were met (Table 2). The benchmark for acceptability was unmet. Intervention sessions primarily occurred in participants' homes (n = 228 sessions). The intervention was also delivered by telephone (n = 1 session) and in the clinic (n = 10 sessions).

Table 1. Participant Characteristics (*N* = 21)

Characteristic	*M* (*SD*) or *n* (%)	
Age, yr	70.8	(10.9)
Race		
White	17	(81.0)
Black/African American	3	(14.3)
American Indian/Alaskan Native	1	(4.8)
Social support (has caregiver support)	7	(33.3)
Stroke type, ischemic	19	(90.5)
Hemisphere affected		
Left	12	(57.1)
Right	7	(33.3)
Bilateral	2	(9.5)
Chronicity, mo	14.34	(29.4)
Gender, male	8	(38.1)
Education		
<High school	1	(4.8)
High school	9	(42.9)
>High school	11	(52.4)
Comorbidity severity score[a]	3.36	(6.7)
Fatigue[b]	8.12	(49.9)
Worst pain[c]	3.04	(5.1)
Mood[d]	3.25	(3.6)
Cognition[e]	12.67	(98.8)
Mobility[f]	17.43	(77.3)
ADL/IADL function[f]	17.32	(81.9)

Note. Percentages may not total 100 because of rounding. ADL = activities of daily living; IADL = instrumental activities of daily living.
[a]Self-Administered Comorbidity Index, range = 0–45; low scores indicate low comorbidity severity. [b]PROMIS Fatigue Scale 8a, *M* = 50, *SD* = 10. [c]Numeric Pain Rating Scale, range = 0–10; low scores indicate low pain. [d]Patient Health Questionnaire–9, range = 0–27; low scores indicate low levels of depressive symptoms. [e]NIH Toolbox Cognition Total Composite Score, *M* = 100, *SD* = 15. [f]Stroke Impact Scale (respective subscale), range = 0–100; low scores indicate low function.

Change in Clinical Outcomes

Sedentary behavior (ActivPAL micro3) and participation (SIS–P) were considered stable at baseline (Table 3). The mean group reduction in sedentary behavior was 54.95 min (SD = 81.10, Cohen's d = 0.70) at T1 and 14.08 min (SD = 58.95, Cohen's d = 0.18) at T2. Seven participants achieved a reduction of >60 min per day at T1, and 2 of these participants sustained this level of change at T2. Two additional participants achieved a reduction of >60 min per day at T2. Plots of individual and group change are displayed in Figure 1. The mean group increase in participation over time was 1.48% (SD = 8.52, Cohen's d = 0.12) at T1 and 1.33% (SD = 15.38, Cohen's d = 0.23) at T2.

Discussion

Consistent with best practices in piloting complex interventions, this study was designed to assess feasibility and to describe changes in sedentary behavior that may be associated with the ABLE intervention (Moore et al., 2011). The ABLE intervention was safely and reliably delivered and adhered to by participants. The benchmark for acceptability was unmet. The ABLE intervention was associated with reductions in prolonged sitting at postintervention that exceeded 30 min per day, a level that is associated with reduced risk of all-cause mortality (Diaz et al., 2017). This level of reduction was not maintained at follow-up, implying that the ABLE intervention may be promising for reducing prolonged sitting time but requires refinement to bolster sustained intervention effects.

The present research builds on existing evidence that supports the feasibility of behavioral interventions to reduce sedentary behavior among people with stroke (English et al., 2016; Ezeugwu & Manns, 2018). The ABLE intervention integrates the use of meaningful activities (English et al., 2016) and activity scheduling (Ezeugwu & Manns, 2018) by means of behavioral activation to promote engagement in activities that may reduce sedentary behavior.

During this early phase of intervention development, we must consider potential reasons for variability in satisfaction and sedentary behavior outcomes. Reasons for variability may include readiness to change (Knittle et al., 2018) and environmental factors (Sallis & Owen, 2015). The Transtheoretical Model suggests that motivation for health behavior change advances through six stages, ranging from Precontemplation (no intention to enact change in the near future) through Termination (change has occurred, and there is no intention of returning to prior behavior; Prochaska et al., 2015). People in early stages of readiness for change are less likely to change their behavior (Prochaska et al., 2015). Some people in the Precontemplation stage remain there because they are unaware of the health risks associated with the behavior (Prochaska et al., 2015). Older adults have reported that some sedentary behaviors are perceived to have positive social outcomes rather than detrimental health outcomes (Palmer et al., 2019). Those for whom sitting time primarily occurs during social activities may not perceive a need to change this behavior. Examinations of readiness for change and stroke survivors' perceptions of the risks and benefits of activities that involve sitting will be important in advancing the development of poststroke sedentary behavior interventions.

Table 2. Intervention Feasibility (*N* = 20)

Intervention	Benchmark	Result
Reliability, %		
Activity scheduling	90.0	95.0[a]
Activity monitoring	90.0	97.5[a]
Self-assessment	90.0	95.0[a]
Collaborative problem solving	90.0	90.0[a]
Satisfaction, score on 4-point Likert scale		
Client Satisfaction Questionnaire–8	≥28.8	28.75 (3.84)
Adherence		
Attendance (days/session)	10.80	11.95 (0.22)[a]
Session frequency (days/session)	—	2.77 (0.60)
Session length (min)	—	34.22 (8.76)
Safety, *n*		
Serious (i.e., injurious) adverse events	0	0[a]
Noninjurious fall	—	1

Note. Dashes indicate not applicable or data were not collected. Values in parentheses are the standard deviation for the measure indicated.
[a]Benchmark met.

Social and built environments may also influence sedentary behavior outcomes. Stroke survivors experience changes in social networks (e.g., avoidance of social interactions, restricted participation in social groups) that may influence the frequency of engagement in daily activities (Dhand et al., 2018). The built environment (e.g., stairs, accessible restrooms) may also influence stroke survivors' engagement in activities (Hammel et al., 2015). Existing sedentary behavior interventions, including the ABLE intervention, emphasize modifying the stroke survivor's behavior; however, when an intervention ends, stroke survivors' preexisting social and built environments often remain unchanged. These social and built environments may facilitate a return to preintervention levels of sedentary behavior. Defining active ingredients that act on the social and built environments may be important for developing interventions in which outcomes persist beyond the intervention delivery period.

Limitations

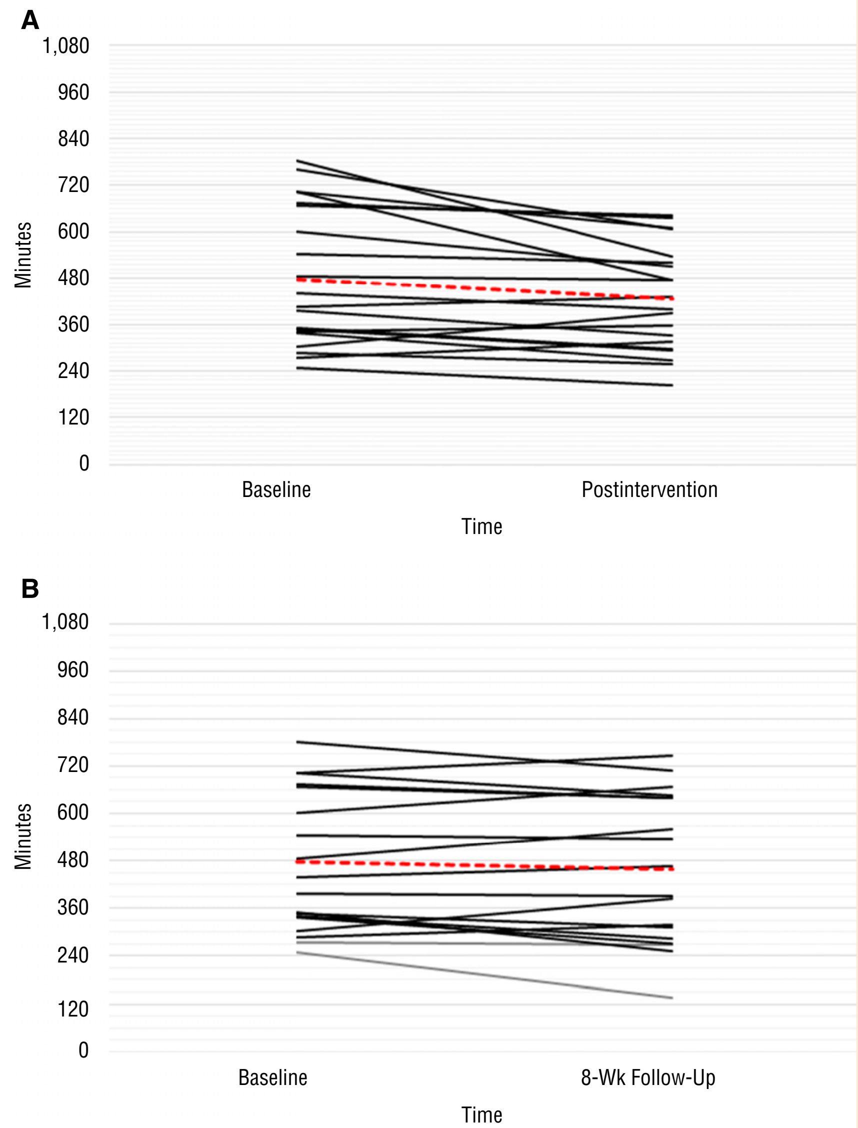
These preliminary effects must be interpreted with caution. The ABLE intervention was piloted using a single-group design, strengthened by a dose-matched delayed baseline; therefore, the cause of change over time cannot be attributed to the ABLE intervention. This study was designed to assess feasibility and estimate effect sizes that will guide future clinical trials (Moore et al., 2011). Thus, it was not designed to assess the statistical significance of change over time. Lessons learned in this study are useful for refining the intervention and designing the next phase of intervention development. Moreover, our sample consisted of people who were older, were primarily female, and had relatively low levels of comorbidity. This may not represent the entire population that could benefit from the ABLE intervention. Future studies should stratify participant recruitment and use larger sample sizes to obtain estimates across the broader population with stroke.

Table 3. Change Over Time on Clinical Outcomes, *M* (*SD*) (*N* = 20)

Outcome	Baseline Raw Score	Baseline Standard Score	Postintervention Raw Score	Postintervention Standard Score	8-Wk Follow-Up[a] Raw Score	8-Wk Follow-Up[a] Standard Score
M daily min prolonged sitting (≥30 min), ActivPAL micro3	466.56 (168.65)	476.30 (177.49)	437.72 (147.34)	427.52 (137.03)	454.95 (181.12)	457.19 (188.91)
CV, %	8.81		—		—	
Within-group Cohen's *d* (95% CI)	—		0.70 (–0.01, 1.24)		0.18 (–0.47, 0.84)	
Participation (%), Stroke Impact Scale–Participation subscale	73.36 (22.26)	—	75.16 (21.45)	—	75.00 (25.87)	—
CV, %	8.32		—		—	
Within-group Cohen's *d* (95% CI)	—		0.12 (–0.50, 0.74)		0.23 (–0.41, 0.90)	

Note. Dashes indicate not applicable. ActivPAL micro3 sedentary minutes were standardized to mean within-person waking time across all time points. Positive effect sizes indicate a change in the expected direction. CI = confidence interval; CV = coefficient of variation over delayed baseline.
[a]*n* = 18 for 8-wk follow-up for ActivPAL measurements.

Figure 1. Spaghetti plots demonstrating change in total sitting time accumulated in increments of ≥30 min: (A) baseline to postintervention and (B) baseline to 8-wk follow-up.



Note. Individual change and the group mean change are represented. The top panel shows change from baseline to postintervention, with a group mean reduction of 54.95 (*SD* = 81.10) min/day. The bottom panel shows change from baseline to the 8-wk follow-up, with a group mean reduction of 14.08 (*SD* = 58.95) min/day.

Implications for Occupational Therapy Practice

The results of this study have three overarching implications about the ABLE intervention as it pertains to occupational therapy practice:

- The ABLE intervention was safe, the intervention schedule was adhered to, and the intervention was consistently delivered (i.e., reliable) among people with chronic stroke.
- ABLE was associated with reductions in daily prolonged sitting at postintervention (54.95 min) that were not maintained at follow-up (14.08 min).
- ABLE shows promise for influencing poststroke sedentary behavior. Further exploration of stroke survivors' readiness to change and environmental influences on sedentary behavior will advance this work.

Conclusions and Future Directions

The results of this pilot feasibility study of the ABLE intervention add to an emerging body of intervention development that aims to reduce sedentary behavior among people with stroke. To advance these interventions, future studies should explore the role of readiness to change and environmental factors that may influence sedentary behavior outcomes. These studies will guide occupational therapy professionals to active ingredients that leverage readiness to change and environmental factors that can promote health through engagement in meaningful activities. Once these interventions have been refined, clinical trials and implementation studies will establish the efficacy and effectiveness of interventions that reduce sedentary behavior among stroke survivors.

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