

Promoting Alzheimer's Risk-Reduction through Community-Based Lifestyle Education and Exercise in Rural America: A Pilot Intervention

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ABSTRACT

Introduction. Rural Americans (RA) have poorer vascular health and physical activity levels than their urban counterparts; all are dementia risk factors. Dementia risk reduction among rural individuals requires a tailored approach. The purpose of this project was to examine preliminary efficacy of a community-based physical exercise and/or dementia risk factor-reduction curriculum among rural adults 50 and older.

Methods. Seventy-five rural dwelling adults 50 and older were randomized to one of three groups: 1) 10 weeks of Alzheimer's disease risk-reduction education (ED), 2) risk-reduction education and supervised exercise (EDEX) or 3) control group (CON). Outcomes included baseline to 10-week follow-up difference in dementia knowledge (primary outcome) and physical activity, muscular endurance, healthy lifestyle engagement, and anthropometrics (secondary outcomes).

Results. Sixty-nine adults successfully completed the 10-week study. Dementia knowledge increased in a Treatment Arm-dependent manner ($\chi^2 = 6.95$ (2), $p = 0.03$), being ED and EDEX superior to CON. Engagement in healthy lifestyle behaviors did not change statistically. However, participation specifically in physical activity increased over time ($\chi^2 = 11.47$ (2), $p = 0.003$) with EDEX reporting the greatest increases. No significant change in average daily steps was observed for any group.

Conclusion. The results suggested dementia risk-reduction education, both with and without structured exercise, leads to improvements in dementia knowledge. When coupled with regular, supervised exercise, this education intervention also helped participants increase engagement in physical activity over 10 weeks. Tailored interventions that combine Alzheimer's disease education and regular, supervised exercise may help reduce dementia risk in rural communities.

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INTRODUCTION

Alzheimer's disease (AD) and related dementias (ADRD) are a pervasive and costly problem for the American health care system. Serious public health threats in the U.S. related to ADRD include mortality, disability, family impact, and costs to the health care system.¹ Several lifestyle behaviors have been identified as ADRD risk reducing behaviors. These risk-reducing behaviors are physical activity and exercise²⁻¹⁸, healthy diet¹⁹⁻²², social and cognitive engagement²³⁻³¹, quality sleep³²⁻³⁶, and stress management.³⁷⁻⁴² Research suggested that individuals who regularly participate in these behaviors are at a lower risk of developing cognitive impairment than those who do not.¹³

Rural Americans (RAs) are at a higher risk of ADRD, due to a number of factors, including unique barriers to healthy lifestyle resources, lower levels of formal education attainment⁴³⁻⁴⁵, prevalence of obesity-related behaviors, and inadequate access to preventive and specialist care. For example, though 17% of the U.S. population live in rural communities, only 9% of registered physicians practice in these areas, limiting access to high quality healthcare.^{46,47} RAs often harbor unfavorable attitudes toward healthy lifestyle behaviors like exercise, physical activity, and healthy diet.^{43,45-49} They also face unique barriers to physical activity and exercise compared to urban or metropolitan dwelling Americans. Common barriers faced by RAs are sidewalk availability, indoor walking spaces, safety, wanting to feel attached/community, and lack of companionship.⁴³⁻⁴⁵ Health-related misconceptions also may pose a potential barrier for RAs.⁴³ The belief that physical activity and/or exercise is too strenuous may prevent individuals from engaging in recommended physical activity necessary to attain a healthy lifestyle.

ADRD education interventions might be key for reducing ADRD disparities among RAs. According to the Health Belief Model, an individual is more likely to attempt to reduce their disease risk if they have the desire to avoid that illness and if they perceive the disease as modifiable.⁵⁰ Individuals will have the desire to avoid the disease risk if they perceive it as a threat. This model emphasizes the importance of educating on disease preventive actions and reducing potential barriers. Following this model, we developed and piloted the short-term efficacy of a 10-week community-based education and exercise program that addressed the barriers to healthy lifestyles of RAs in a Midwest town (< 25,000 inhabitants in 12 square miles, 60 miles away from the closest urban city). We hypothesized that the 10-week intervention program, including both supervised group exercise and ADRD risk-reduction education would lead to significant improvements in a number of ADRD risk behavioral and physiological outcomes.

METHODS

Study Setting and Participants. Seventy-five rural dwelling adults were recruited for a 10-week, community-based education and exercise intervention program. Individuals were eligible to participate if they met the following criteria: lived in a federally designated rural or frontier county; willing to drive to a central site for community-based education and/or exercise sessions; free of chronic disease preventing exercise, have no diagnosis of cognitive impairment; be age 50 to 85; be underactive (according to the Telephone Assessment of Physical Activity [TAPA⁵¹]); have no physical limitations preventing them

from moderate intensity exercise (as assessed by the Physical Activity Readiness Questionnaire [PAR-Q⁵²]); be able to attend a minimum of 80% of the education and exercise sessions offered. Participants were recruited via radio, flyers, and word of mouth in a single wave of enrollment. Participants were randomized to one of three arms: Control (CON), education only (ED), or education + facilitated group exercise (EDEX) in a 1:1:1 ratio. All study testing and intervention took place at a Carnegie MI university located in a rural county.

Interventions

Education Curriculum. In 2015, an educational curriculum aimed at reducing risk factors for ADRD in cognitively normal adults, closely adhering to standard public health recommendations⁵³⁻⁵⁵ was developed by a team of ADRD risk-reduction researchers from a major medical center located in the Midwest. This curriculum included evidence-based practical lifestyle strategies linked to ADRD risk reduction. The curriculum materials included a manual, numerous handouts on ADRD, ADRD risk-reduction strategies and healthy lifestyle behaviors, research highlights, presentations, and interactive activities associated with each lifestyle behavior. The curriculum was developed originally in conjunction with community members at urban and suburban senior living communities and community forums. The curriculum also has been culturally adapted for other underserved groups.⁵⁶

Curriculum materials referencing community resources were modified to apply to the rural communities represented in this study and re-introduced as the Wheat State curriculum. Modifications included the introduction of small group discussion and interactive activity formats into weekly presentations, references to local resources, career, and lifestyle behaviors specific to the study population (i.e., farming, ranching, rural life). These modifications were necessary to promote resources available to this specific population effectively and provide strategies to combat real-life barriers these participants faced living in the rural Midwest. These sessions provided background information on ADRD, ADRD risk, exercise and cognitive function, trends in rural America, current research, exercise modalities, and other related topics. Participants received handouts and educational resources in addition to the curriculum manual throughout the course of the study to promote maintenance of the learning achieved during the sessions. For this project, the curriculum was organized into eight modules taught over the course of 10 weeks, one time a week, 90 minutes per session (Table 1).

Exercise Curriculum. The exercise curriculum was based on a combination of standard public health recommendations and previously published research.^{5,8,13,15,17,54,57-59} Multiple exercise sessions were offered each day of the week to accommodate participant schedules. Participants assigned to the EDEX group were required to attend an exercise session and an education session on the same day once weekly. Each exercise session included a five-minute warm-up, aerobic exercise, resistance training exercises, and a five-minute cool-down. Aerobic exercise was performed on one of the following: 160 m indoor walking/jogging track, treadmill, or elliptical trainer. Participants were trained to use a modified Rated Perceived Exertion (RPE) scale (1 - 10) to assess their intensity level, and exercise at a moderate intensity (i.e., 5 - 6).⁶⁰

Table 1. LEAP! Smart Aging Manual contents.

Week	Wheat State curriculum educational sessions for ED and EDEX	General exercise prescription for EDEX only
Week 1	Introduction & Chapter 1 - Introduction and Alzheimer's Basics	60 min. moderate intensity aerobic exercise/2 sets 10 reps on 10 resistance exercises
Week 2	Chapter 2: Part I - Sedentary Behavior	60 min. moderate intensity aerobic exercise/2 sets 10 reps on 10 resistance exercises
Week 3	Chapter 2: Part II - Physical Activity	68 min. moderate intensity aerobic exercise/2 sets 12 reps on 10 resistance exercises
Week 4	Chapter 3: Exercise	76 min. moderate intensity aerobic exercise/2 sets 12 reps on 10 resistance exercises
Week 5	Chapter 4: Part I - Nutrition	84 min. moderate intensity aerobic exercise/3 sets 8 reps on 10 resistance exercises
Week 6	Chapter 4: Part II - Nutrition	92 min. moderate intensity aerobic exercise/3 sets 8 reps on 10 resistance exercises
Week 7	Chapter 6: Part I - Social Engagement	100 min. moderate intensity aerobic exercise/3 sets 8 reps on 10 resistance exercises
Week 8	Chapter 6: Part II - Cognitive Engagement	108 min. moderate intensity aerobic exercise/3 sets 10 reps on 10 resistance exercises
Week 9	Chapter 7: Sleep	60 min. moderate intensity aerobic exercise/3 sets 10 reps on 10 resistance exercises
Week 10	Chapter 8: Grief, Depression and Stress Management	60 min. moderate intensity aerobic exercise/3 sets 10 reps on 10 resistance exercises

During the first week of training, participants performed 60 minutes of cumulative aerobic exercise (20 minutes per session) and two sets of ten repetitions on a variety of resistance training exercises. Both aerobic and resistance training components of the exercise sessions gradually increased in volume, peaking by week eight with 108 minutes of aerobic exercise and three sets of ten repetitions on each strength exercise. For resistance training, modifications were provided for all exercises and each participant was progressed as individual technique and fitness level allowed. Participants were instructed to increase the weight used for any given exercise when they safely could perform at least two additional repetitions than that assigned with a given weight. Ideal exercise progression is included with the curriculum in Table 1.

Treatment Arms. Participants were randomized to a treatment arm after baseline testing, then given an activity monitor (Vivofit 3, Garmin Ltd.) and educated on its use. Weekly physical activity data (as measured by daily steps counted on the activity monitor) were collected and synced to a computer at weekly education sessions, or at a predetermined location for the Control Group (CON) participants. Activity data were made available to the participant and the research

team on the manufacturer internet dashboard throughout the study.

Education Group (ED). Participants in the ED group received an activity monitor, the Wheat State curriculum manual, weekly group education sessions, and were encouraged to increase physical activity levels. Education sessions were 70 - 90 minutes in duration. While physical activity and exercise were encouraged, no in-person exercise training was provided. Physical activity tracking devices were synced each week during the education session to allow the research team to track physical activity levels of each participant. Participants were required to attend at least 8 of the 10 educational sessions to be considered compliant with the intervention.

Education + Exercise Group (EDEX). EDEX participants participated in weekly group exercise in addition to attending the weekly education sessions. Exercise sessions for the EDEX group were led by an exercise science faculty member and trained student interns. EDEX participants were expected to exercise in a semi-group format three times each week. Personalized exercise logs were provided for each participant each week. These logs provided participants with the prescribed exercise for both aerobic and strength exercises and included space to record total distance covered (aerobic exercise), weight used for each strength exercise, and general notes for information the participant wished to record. Exercise logs from previous weeks were provided at each exercise session to allow participants to review distance covered during previous weeks, weight used for each exercise, and additional notes recorded.

To accommodate participants, six exercise sessions were offered weekly. Participants were allowed to exercise during any of the available, non-consecutive sessions, allowing a minimum of 24 hours between exercise bouts. Participants who planned to miss an exercise session due to travel were provided with an exercise training document to use while out of town. EDEX participants were required to attend 24 of the 30 exercise sessions, and 8 of the 10 education sessions to be considered compliant with the intervention. Participants with more than two absences from education or six absences from exercise were dropped from the study.

Control Group (CON). Participants randomized to the CON group were given an activity monitor and the Wheat State curriculum manual. Participants in this group were asked to meet a member of the research team every few weeks to sync their physical activity tracking device. Aside from baseline and post-intervention assessment and this interaction, CON participants did not participate in any additional study procedures, were not given instructions to follow recommendations from the Wheat State curriculum manual, and were encouraged to continue their normal activities in terms of exercise.

Outcomes. For estimating preliminary efficacy, a range of behavioral and physical outcomes were measured that may be linked to ADRD risk. The baseline evaluation consisted of the following outcome assessments. Our primary outcome was ADRD knowledge using the Alzheimer's Disease Knowledge Scale (ADKS).⁶¹

Additional measures of interest included self-reported adherence to healthy lifestyle behaviors using a modified Health Promoting Lifestyle Profile II (HPLPII) total score and its physical activity component.^{62,63} The HPLPII is a 52-item scale that employs a 4-point response format (never, sometimes, often, or routinely) to measure the frequency of self-reported health-promoting behaviors in the domains of health responsibility, physical activity, nutrition, spiritual growth, interpersonal relations, and stress management. Total scores range from 52 to 208, higher meaning more optimal health behaviors. The HPLPII physical activity dimension is measured with eight of its items. Average weekly physical activity was measured as average daily step count for at least three of seven consecutive days at baseline and follow-up by a wrist-worn (non-dominant) activity monitor.^{64,65} Remaining outcomes included 30-second Chair Stand Test as a measure of muscular endurance⁶⁶ and body weight. Upon completion of the 10-week study, participants returned and performed the same assessments within seven days of study completion.

Data Analysis. Statistical analyses on all outcome measures was performed using R.⁶⁷ Mixed-model analyses were conducted on pre-specified outcomes by entering Treatment Arm (CON, ED, EDEX) and Timepoint (Baseline, Week 10) into the model as fixed effects and included random intercepts for participants. The primary effect of interest was a Timepoint by Treatment Arm interaction. P-values were obtained with type-III Wald F-tests of each model against a simplified model without the interaction of interest. The total number of steps by the end of the intervention was compared among intervention groups using ANOVA and Tukey post hoc tests as a secondary analysis. Statistical significance was established at $\alpha < 0.05$.

RESULTS

Description of the Study Population. Seventy-five rural dwelling adults enrolled in the study. One ED participant dropped out of the study due to inability to attend education sessions. Five participants were consented but failed to attend baseline assessments. The remaining 69 adults successfully completed the 10-week study (17 males, 52 females; mean age 63.9 ± 8.0 years). Demographics of completing participants are presented in Table 2. All participants were residents of federally designated rural or frontier counties in the state of Kansas, 27 living in a country setting, outside city, or town limits. The remaining 42 lived within city or town limits of small communities within the region. Participants' sex differed by intervention group ($p = 0.014$), and there were 95.7% women in CON, 70.8% in ED and 57.1% in EDEX. Participants did not differ statistically in any other key characteristic.

Outcomes. Baseline and follow-up outcomes are detailed in Table 3. ADRD knowledge increased over the study in a Treatment Arm-dependent manner ($\chi^2 = 6.95$ (2), $p = 0.03$). ED and EDEX groups increased their ADRD knowledge more than the CON group. Reported engagement in healthy behaviors (HPLPII) increased across all groups, regardless of group (no interaction effect, $\chi^2 = 4.94$ (2), $p = 0.08$). However, the physical activity component of the HPLPII showed a change over the course of the study in a Treatment Arm-dependent manner ($\chi^2 = 11.47$ (2), $p = 0.003$) with the EDEX group reporting the greatest increases in physical activity.

Table 2. Baseline characteristics of study participants.

Characteristics	Total (n = 69)	CON (n = 23)	ED (n = 24)	EDEX (n = 22)	Between groups p Value
Age, mean (SD) yrs.	63.9 (8.0)	62.7 (1.7)	64.8 (1.5)	64.2 (1.8)	0.667
Female, No. (%)	52 (75.4)	22 (95.7)	17 (70.8)	13 (57.1)	0.014
Weight, mean (SD) lbs.	178.8 (42.4)	174.6 (32.7)	173.2 (44.9)	189.3 (48.2)	0.377
Systolic blood pressure	121.8 (15.3)	118.1 (14.5)	123.6 (14.7)	123.6 (16.7)	0.382
Diastolic blood pressure	78.0 (10.4)	76.0 (10.5)	79.2 (9.5)	78.9 (11.2)	0.525
HPLPII Physical Activity	18.4 (5.3)	18.2 (5.1)	18.7 (6.0)	18.2 (5.0)	0.942
Dementia Knowledge (ADKS)	25.3 (2.6)	25.0 (3.0)	25.0 (2.7)	25.9 (1.9)	0.450
Setting					0.256
Country resident, No. (%)	20 (33.3)	8 (50.0)	6 (27.3)	6 (27.3)	
Residing within rural town, No. (%)	40 (66.7)	8 (50.0)	16 (72.7)	16 (72.7)	
Race/ethnicity, No. (%)					
White	69 (100%)	23 (100%)	23 (95.83%)	22 (100%)	0.39
Hispanic	1 (1.4%)	0 (0)	1 (4.17%)	0 (0)	--
Black/African American	0 (0)	0 (0)	0 (0)	0 (0)	--
Other	0 (0)	0 (0)	0 (0)	0 (0)	--
Retired, No. (%)	40 (58.0)	12 (52%)	9 (38%)	12 (55%)	0.450

Table 3. Preliminary efficacy outcomes.

		Baseline	Follow-up	Group time p value
Dementia Knowledge (ADKS)	n	Mean (SD)	Mean (SD)	0.03
CON	23	25.0 (3.0)	26.4 (2.3)	
ED	24	25.0 (2.7)	28.0 (2.7)	
EDEX	22	25.9 (1.9)	28.5 (1.6)	
Overall Healthy Lifestyle Self-rating (HPLPII)				0.08
CON	23	83.2 (12.3)	90.1 (11.0)	
ED	24	84.7 (14.5)	91.3 (14.9)	
EDEX	22	84.5 (11.6)	96.5 (11.0)	
Physical Activity Self-rating (HPLPII)				0.003
CON	23	18.2 (5.1)	20.2 (4.7)	
ED	24	18.7 (6.0)	21.1 (5.1)	
EDEX	22	18.2 (5.0)	23.6 (3.8)	
Muscular Endurance (30-s Chair Stand Test)				0.004
CON	23	15.4 (3.5)	16.4 (4.1)	
ED	24	15.7 (3.5)	17.7 (3.8)	
EDEX	22	15.6 (2.8)	19.6 (2.7)	
Body Weight (lbs.)				0.013
CON	23	174.6 (32.7)	173.7 (32.5)	
ED	24	173.2 (44.9)	171.9 (43.1)	
EDEX	22	189.3 (48.2)	184.8 (46.4)	

Table 3. Preliminary efficacy outcomes. *cont.*

		Baseline	Follow-up	Group time p value
Average Weekly Step Count (steps/day)				0.23
CON	23	7,858 (2,687)	7,670 (2,856)	
ED	24	9,902 (4,513)	9,537 (4,748)	
EDEX	22	9,911 (2,738)	10,673 (3,538)	

CON: Control group; ED: Alzheimer's disease risk-reduction education; EDEX: risk-reduction education and supervised exercise; ADKS: Alzheimer's Disease Knowledge Scale; HPLPII: Health Promoting Lifestyle Profile II.

No significant change in daily step count was observed for any group between week one and follow-up testing ($\chi^2 = 2.90$ (2), $p = 0.23$). However, there was evidence that the intervention increased daily physical activity. At follow up, EDEX subjects accumulated on average $10,673 \pm 3,538$ daily steps, and ED subjects accumulated $9,537 \pm 4,748$ steps, while CON subjects accumulated $7,670 \pm 2,856$ steps. In a secondary analysis, one-way ANOVA with Tukey's post-hoc test identified differences in average total weekly steps between the EDEX and CON groups ($F = 3.6$, $p = 0.033$).

Muscular endurance, as measured by the 30-second Chair Stand Test, increased over the course of the intervention in a manner dependent on intervention ($\chi^2 = 11.13$ (2), $p = 0.004$), with the greatest gains in the EDEX group (4 stands). Body weight decreased over the intervention. The Timepoint by Treatment Arm interaction was significant for body weight, ($\chi^2 = 8.76$ (2), $p = 0.013$), with the EDEX group losing the most weight (4.42 ± 4.88 lbs.).

DISCUSSION

To our knowledge, this is the first study to assess the use of an ADRD risk-reduction curriculum to stimulate increased physical activity and/or exercise in rural dwelling adults 50 and older. Although there have been numerous investigations into the effectiveness of exercise interventions on improving physical fitness measures, few have examined such programs in rural settings. The results suggested that a culturally relevant program with active engagement can be employed in underserved regions to reduce ADRD risk.

In this study, the Education + Exercise (EDEX) group achieved better improvements in several measures following the 10-week intervention relative to the other groups. EDEX participants increased their knowledge of ADRD, increased their physical activity and muscular endurance, and experienced greater weight loss than control participants. Given the requirements of the intervention, it is perhaps not surprising that EDEX participants achieved higher levels of physical activity than the Control (CON) participants. The education-only group (ED) did not accumulate more average daily steps throughout the study period than the CON or EDEX groups, falling between the two. This finding suggested that the education may have a mild effect in motivating positive behavior change, but it is likely necessary to provide some exercise supervision to increase physical activity meaningfully. It is important to note that this was a sample population that vol-

untarily chose to participate in a lifestyle behavior intervention study. There is a possibility that these individuals were more motivated to make lifestyle changes than individuals who did not volunteer for this study. Further, the finding that the EDEX group accumulated a greater number of weekly steps than the CON group is based on a secondary analysis and caution is warranted when interpreting this finding.

The results from this study supported evidence from previous investigations that report positive results following exercise interventions. However, the unique contributions of this intervention are that (1) it utilized ADRD risk reduction education, coupled with exercise to promote increased physical activity and exercise and (2) it allowed education and exercise to be delivered in group and semi-group formats, as opposed to more traditional individual exercise sessions often used in clinical research. The group format may have provided camaraderie, as well as accountability, and may have contributed to the high compliance rates of participants. Community-based group exercise programs for older adults, when delivered well, have long-term exercise adherence rates of nearly 70%.⁶⁸ Individuals with cognitive decline seem to benefit from group exercise opportunities as well.⁶⁹ In general, older adults have greater exercise enjoyment and are more likely to adhere long-term (> 3 months) when participating in supervised group exercise opportunities.⁷⁰ The group exercise format offers numerous benefits, including social connectedness and participant empowerment.⁶⁸ It is our suggestion that the social relationships and personal empowerment gained from participating alongside peers may have played a key role in the high adherence rates reported in this particular study.

Limitations. This study had limitations that warrant consideration. First, the study population was drawn from one specific region of the rural midwestern U.S. and was comprised of primarily non-Hispanic White women. Results from this study may not be directly applicable to men, more ethnically diverse rural communities, or more remote geographic locations. Second, to increase compliance, physical activity data were collected via commercially marketed wearable technology. Thus, the research team relied on proper functioning of the devices utilized. On occasion, devices failed and had to be replaced resulting in minor data loss and participant frustrations. Unfortunately, the frequency of this occurrence was not recorded. However, at least three days of step data at baseline and follow-up testing were captured for all participants, allowing for full

analysis. Nevertheless, the physical activity feedback that participants received during the intervention may have been inaccurate.

Participants in the present study were familiarized with the devices and had little anecdotal trouble with incorporating them into a daily routine. Most devices store user data for weeks or months and require minimal to no manual daily adjustments, making them easier to use than traditional pedometers. For this reason, these devices are becoming more frequently used in exercise and physical activity research. The particular device used in this study stored data for 30 days, contained a one-year battery (which required no charging), and could be adjusted to sync automatically with a smart phone or parent computer. The devices used were chosen for these characteristics. We wanted to avoid participants removing and/or losing devices and hoped to provide a user-friendly experience for adults 50 and older. While other devices may have provided greater accuracy or advanced metrics, this device provided fewer barriers to use for adults 50 and older. Finally, longer investigations are needed to gain a deeper understanding of exercise intervention outcomes and long-term exercise adherence following education and/or exercise interventions.

CONCLUSIONS

The community-based education and exercise intervention provided a means of addressing ADRD-related healthy lifestyle disparities by increasing ADRD knowledge and common measures of physical function for adults 50 and older in a rural setting. Individuals who participate in such programs may gain valuable physical benefits that have been associated with improved brain health. Future work should investigate methods to increase physical activity reliably, and sustainable models of delivery.

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