IJREP

International Journal of Research in Exercise Physiology

Original Research Article

5-week Hybrid Exercise and Education Intervention on Sleep Patterns in Older Adults: A Pilot Study

Rachel Breu[1], Adyson Bellis[1], Grace Jones[1], Gretchen Petraszak[1], Ella Pratt[1], Saori Braun[1†] and Marquell Johnson[1†]

[1]Department of Kinesiology, University of Wisconsin-Eau Claire, WI, USA

[†]Denotes faculty mentor(s)

ABSTRACT

PURPOSE: To examine the impact of a 5-week hybrid exercise and education intervention on sleep patterns in rural community-dwelling older adults. **METHODS:** This experimental pilot study included 10 older adults (age = 79.6 ± 8.87 years) recruited from a community-based senior center in rural northwest Wisconsin. Participants wore an accelerometer on their dominant wrist and an inclinometer on the mid-thigh of their non-dominant leg over a 7-day period for 24 hours each day, except when bathing. Total sleep time (TST), total time to sleep, sleep efficiency, total number of awakenings, and average length of awakenings were obtained from devices at baseline (BL) and during the 5th week of the hybrid exercise intervention (DI), which comprised of a weekly 30 minute education session on exercise modes, benefits of exercise, and sleep importance and a tri-weekly 60-minute exercise sessions in-person (1 day) and synchronously (2 days) over a 5-week period. Exercise sessions incorporated muscle strengthening exercises using exercise bands, light free weights, and stretches, many were completed in seated position. Paired samples t-tests were employed to examine the changes in sleep variables from BL to DI. **RESULTS:** Daily TST obtained from a thigh-worn inclinometer had no significant changes from BL (5.63 ± 1.78 hours/night) to DI (6.80 ± 2.66 hours/night), $t(7) = -9.53$, $p = .206$. Time to sleep, sleep efficiency, number of awakenings, average length of awakening had no statistical significance. Physical activity and postural changes did not change significantly. **CONCLUSION:** Although there was no sleep significance, this pilot test demonstrated benefits of a 5-week hybrid intervention among rural older adults.

Keywords: Sleep Quality, Hybrid Program, Rural Healthcare

INTRODUCTION

One in two older adults report sleep problems, which not only causes fatigue but also negatively affects general functioning, activities of daily living (ADL), and physical and mental health[1]. As individuals grow older, quality of sleep tends to change due to the physiological effects of aging[1]. Recent

literature findings have suggested the positive impact exercise has on sleep variables. Specifically, resistance training has been proven to improve individuals' sleep patterns[2]. It is also beneficial to have representation of exercise programs in rural communities as it has been shown that low-cost virtual/remote exercise intervention was effective for individuals living in a rural population[3].

A large number of online interventions spiked in 2020, which coincided with the COVID-19 pandemic[4]. A virtual exercise program implemented by a research team found an improvement in physical activity and functional fitness measures[5]. Previous studies evaluated sleep patterns in older adults, and there is strong research on how exercise implementation benefits older adults. For instance, a low to moderate exercise intervention was conducted for 20-70 minutes per week for 12 weeks[1]. After the intervention, the exercise program had been shown to improve overall sleep quality in various sleep quality domains. People who received resistance training had better sleep duration, sleep efficacy, and sleep onset duration compared to those who received aerobic training[2]. This indicated the importance of exercise and its effects on sleep quality. Other variables, including life satisfaction and cognition, have been self-reported to see increases with exercise. Those who participated in exercise reported significantly higher scores regarding their life satisfaction[6].

Another study evaluated the effectiveness of a remote versus an in-person education session on feasibility, adherence, and satisfaction, health literacy, and cognition[7]. They found both programs had high satisfaction, feasibility, and adherence, which indicates both are effective delivery methods to impact the geriatric population. This may encourage remote learning for increased accessibility.

The importance of exercise and education in various health issues can be delivered in a hybrid format. It was found that a 6-month educational program about frailty on various health related issues had improved physical function, sleep patterns, and nutrition status in pre-frailty population[8]. The research considers the positives and negatives of hybrid programs. Another study explains at the end of their hybrid intervention; adherence was 84% for exercise sessions. With that, there were troubleshooting fixes with poor internet connection and glitches with the software used[9]. This indicated that despite technology issues, hybrid exercise programs still can have a positive effect on the participants.

People who live in rural areas of the United States are more likely to face more health challenges than urban residents, such as higher mortality rates from chronic diseases[10]. Issues related to accessibility to exercise programs among older adults living in a rural community include the shortage of services within rural communities, travel distances, and lower socioeconomic factors[4]. They also

have higher rates of poverty, less access to healthcare, and are less likely to have health insurance.[10] Considering the current literature, more research was conducted in urban populations where there are more resources regarding exercise programming in the community compared to rural populations. This indicates an area of potential improvement in how future interventions could be designed and different telehealth interventions could target improved nutrition and physical activity levels in rural populations[4].

The purpose of this study was to examine the effect of hybrid exercise on sleep quality and quantity among older adults living in a rural community. By focusing on the rural population, we looked to expand research in this area to diminish various barriers. Not only does the study look at rural populations, but it includes the aspect of a hybrid exercise program format. Hybrid exercise increases feasibility and accessibility to those with limited access while maintaining the benefits of exercise. With that, this study implements educational sessions on various health related topics. They were implemented to enhance the understanding of one's overall well-being and knowledge of various conditions. The research works to extend exercise and education to older adults in rural communities.

Hybrid exercise and education have meaningful benefits to rural communities such as improving sleep quality, increasing physical activity, and educating older adults on health-related topics. The researchers hypothesized that sleep quality among older adults in a rural population would improve with a 5-week moderate intensity exercise program and the implementation of education sessions.

METHODS

Participants

Initial recruitment was conducted by placing an informational flyer at the Senior and Community Center, then a recruitment presentation was given by the researchers to those interested. A convenience sample of 12 older adults living in a rural community were recruited to participate in this study. Institutional Review Board approval was obtained prior to recruitment, and researchers obtained informed consent from each participant prior to data collection. For inclusion criteria, participants had to be 60 years of age or older, free from sleeping disorders such as sleep apnea, and consume no caffeine 3 hours prior to bed. Participants also had to be free from uncontrolled diabetes, pre-existing injury, uncontrolled hypertension, and any symptoms indicative of cardiometabolic and renal disease. Upon screening for eligibility, two participants were excluded from the study. Participant characteristics are shown in Table 1.

Before beginning any testing, all participants completed a sleep quality scale, PARQ, and a Health History Questionnaire (HHQ) to ensure they were eligible for the study. The documents they completed were evaluated for any conditions that would exclude them

from participating in the study. After paperwork, initial functional fitness testing began, which tested their overall fitness before the protocol and establishing a baseline. At the end of the study, all participants filled out another sleep quality scale chart to see if their perceived sleep improved after the protocol and completed a final functional fitness test to see if participants improved in functionality.

Table 1. Participant characteristics by sex

	Male (*n* = 3)	Female (*n* = 7)	Total (*N* = 10)
Age (years)	78 ± 7.79	80.29 ± 9.21	79.6 ± 8.87
Height (cm)	173.67 ± 6.65	154.07 ± 6.99	159.95 ± 11.32
Weight (kg)	92.26 ± 15.14	75.37 ± 11.62	80.44 ± 14.94

Note. Values are presented in mean ± standard deviation for continuous variables.

Instrumentation

ActiGraph wGT3X-BT accelerometer

The ActiGraph GT3X is an accelerometer that is designed to track activity levels, sedentary behavior, and sleep variables. This device was produced by ActiGraph$_{TM}$ located in Pensacola, Florida. In one study, the use of accelerometers to collect sleep data was similarly reliable when compared to a sleep diary and would often only vary by an average of a quarter hour[11]. In this study, the device was used to collect sleep data including quantity of sleep hours per night, number of awakenings, duration of awakenings per minute, and sleep efficiency %. This data was uploaded and entered into Excel to calculate average time in bed, average number of awakenings, average total step count, sedentary time, upright time, stepping time, activity levels, METs and average hourly kcals. Sleep efficiency is calculated by dividing total sleep time by time spent in bed.

ActivPAL inclinometer

This device is designed to measure postural changes such as primary lying, secondary lying, sitting, standing, and stepping. The activPAL device is produced by PAL Technologies LTD in Glasgow, United Kingdom. Primary lying time refers to the longest amount of time spent lying down during the day, typically considered as sleep time and secondary time refers to shorter periods of time lying down that occur during the day. For the purpose of this study, the activPAL device was used to collect data points for quantity of sleep measured in units of hours per night. However, activPAL devices have been found to overestimate sleep time by determining the start of sleep before it begins and estimating wake-up times to be later than reality[12].

Sleep Logs and Sleep Quality

The participants were provided with a sleep log in addition to the wearable devices to aid in data accuracy. The logs included rows for the date, time they went to sleep at night, and time they woke up in the morning. Participants received a sleep log for the baseline week and another one for week 3 of the intervention. The addition of this self-report log aided in the data mining process for the statistical analysis portion of this study. They were also given a Sleep Quality Survey (SQS) pre and post intervention, where they answered questions about their current sleep quality and patterns. These SQS questions were on a scale from almost never to almost always. These scores were added up to indicate sleep quality from 0-86 (86 indicating poor quality). Participants filled out a sleep log every day, rating their quality of sleep the night before out of a 1-10 scale where 1 is not fatigued, and 10 is extremely fatigued.

Functional fitness testing

Functional fitness testing including 30 second chair stand, 30 second arm curl test, 6 foot up and go, sit and reach and back scratch was used to test lower body strength upper body strength and flexibility. The proposed standards were developed for use with a previously validated test battery for older adults-the Senior Fitness Test[13].

Blood Pressure Measurement

The Littmann Stethoscope utilized in the study is widely used by professionals around the United States. This study used the Littmann Cardiology IV 3M stethoscope. Participants were seated with their feet flat on the floor and were instructed to sit and rest for a minimum of 3 minutes prior to blood pressure measurement. All blood pressure measurements were done using the participant's right arm.

Study Procedures

All the necessary paperwork was completed to ensure the participants could participate in the study. Functional fitness testing was completed along with device set-up and distribution in the first week of the study for the pre-test sleep and activity information, for one week of collection time. One week before the end of the study, the devices were redistributed again for the post-test sleep and activity information, for one week of collection time.

The devices included the activPAL and the ActiGraph, which monitors the sleep quality of the participants and monitors their exercise and movement throughout the duration they wore the devices. Participants wore the devices for one week at the beginning of the protocol and then at the end of the protocol to observe changes. Participants tracked the times they woke up and went to bed, noted if they took anything before bed that might affect their quality of sleep, and the times they took off the devices to shower or if they attended an event that might cause excessive sweating.

In-Person and Virtual Exercise Sessions

The intervention was 5 weeks long, with data collection at the beginning and end. The

exercise sessions completed with the participants included moderate-intensity exercises with a warm-up and a cool-down. The group resistance training exercise prescription was given to all participants simultaneously, with individualized modifications given as needed. Student researchers led exercise sessions for a total of three days per week. One day per week, students led an in-person exercise session, and for the other two days, participants were to complete a 60-minute synchronous virtual exercise session. The asynchronous pre-recorded videos were the same duration, 60-minute videos, and were used during university-deemed breaks. Students used four asynchronous pre-recorded videos on days they were unable to personally lead an exercise session due to other classes or meetings.

Participants adhered to the program by using weights and bands that felt comfortable or slightly challenged them for the duration of the exercise protocol. Certain participants noticed physical changes that increased exercise adherence. Adherence was determined from functional fitness testing using the scores they received and finding the weight that works best for them. Options for chair workouts or workouts performed seated were provided for individuals who required a wheelchair or could not stand for a long period. Counterbalancing was completed by encouraging participants to increase their weights and the repetitions of exercises performed each week, which would increase the difficulty when it seemed too easy. Another way to counterbalance exercise adherence is to include new exercises that are more challenging but still of moderate intensity. The student-led classes incorporated new workouts and equipment that participants had never done before or used before, which helped it be a novel experience to participate in.

Statistical Analysis

The experimental pilot study design had 10 eligible participants (n=10). Paired samples t-tests were employed to compare the changes in outcomes variables from baseline to post 5-week intervention. The alpha level was set at .05, and IBM SPSS Software version 29.0 was used for all statistical analyses. The potential cofounding variable consists of exercise adherence and rate of attendance of participants.

Participants tracked sleep quality through a self-reported sleep survey and a log sheet to document sleep onset and awakening. Outcome variables were reported through both the ActiGraph and activPAL devices which measured the impact of exercise on sleep and differences in average: total sleep time, number of awakenings, time of awakenings, sitting time, average laying time, step count, standing time, sedentary time, time of light activity, time of moderate activity, and time of vigorous activity. Mean and standard deviation of the variables is measured to detect changes in sleep patterns post-intervention.

RESULTS

After the exclusion criteria were applied to the 12 participants, there were 10 participants total. Throughout the study, there were no dropouts (N=10). Paired samples t-tests were run for the variables recorded in baseline and post testing using IBM SPSS statistics version 29.0.1.0 to determine the mean difference ± standard deviation. In table 2, functional fitness testing and grip strength scores were depicted for the participants at baseline, post, and the mean difference in these two data periods. The 30-second chair stand test was performed and a mean difference of –1.30 ± 3.65 repetitions was recorded (BL= 12.80 ± 2.82, Post= 11.50 ± 3.54). The 30-second arm curl test was performed, and a mean difference of 1.20 ± 4.02 repetitions was recorded (BL= 21.30 ± 5.25, Post= 22.50 ± 6.22). For the 8 foot up-and-go test, there was a mean difference of –0.61 ± 1.00 seconds (BL= 8.69 ± 2.98, Post= 8.07 ± 3.24). In the sit and reach test, the right leg and the left leg were measured in inches. The right leg for participants had a mean difference of –0.05 ± 2.67 (BL= 0.75 ± 0.92, Post= 0.70 ± 2.91). The left leg for participants had a mean difference of 0.05 ± 1.74 (BL= 0.70 ± 1.06, Post= 0.75 ± 1.90). In the back scratch test, the values were measured for the right arm over and the left arm over. For the right arm over, the mean difference was 4.45 ± 13.64 (BL= -11.20 ± 3.94, Post= -6.75 ± 10.93). For the left arm over, the mean difference was 3.50 ± 9.44 (BL= -11.90 ± 3.14, Post= -8.40 ± 9.34). In testing the grip strength, the combined scores of the right and left hands were recorded in kilograms. Between baseline and post testing, there was a mean difference of 4.40 ± 11.27 kilograms (BL= 48.20 ± 18.58, Post= 52.60 ± 22.21). See table 2 for descriptive statistics of functional fitness tests and results of paired samples t-tests.

Table 2. Functional Fitness Testing and Grip Strength (N=10)

	Baseline	Post	Mean Difference	t-value	p-value
30s Chair Stand (repetitions)	12.80 ± 2.82	11.50 ± 3.54	-1.30 ± 3.65	1.125	.290
30s Arm Curl (repetitions)	21.30 ± 5.25	22.50 ± 6.22	1.20 ± 4.02	0.943	.370
8 foot up-and-go (s)	8.69 ± 2.98	8.07 ± 3.24	-0.61 ± 1.00	-1.936	.085
Sit and Reach (in)					
Right	0.75 ± 0.92	0.70 ± 2.91	-0.05 ± 2.67	-0.059	.954
Left	0.70 ± 1.06	0.75 ± 1.90	0.05 ± 1.74	-0.091	.930
Back Scratch (in)					
Right over left	-11.20 ± 3.94	-6.75 ± 10.93	4.45 ± 13.64	1.031	.329
Left over right	-11.90 ± 3.14	-8.40 ± 9.34	3.50 ± 9.44	-1.172	.271
Grip Strength (kg)	48.20 ± 18.58	52.60 ± 22.21	4.40 ± 11.27	1.235	.248

Note. Values are presented in mean ± standard deviation for continuous variables and in percentage for categorical variable(s); * Less than 0.05 indicates statistical significance.

For measurement of sleep, ActiGraph and activPAL devices were utilized and measures of sleep were collected during both baseline and post intervention testing periods. In table 3, the measured and perceived sleep is reported from the devices and SQS. The ActiGraph evaluated the average time in bed, in minutes, and there was a mean difference of 40.04 ± 78.36 (BL= 358.90 ± 106.20, Post= 398.99 ± 100.58). The average total sleep time, in minutes, had a mean difference of 69.90 ± 162.34 (BL= 337.91 ± 107.09, Post= 407.81 ± 159.48). The average sleep efficiency, in percentage, had a mean difference of 0.44 ± 3.13 (BL= 93.51 ± 4.26, Post= 93.94 ± 4.22). The ActiGraph also records the average number of awakenings, and the mean difference in baseline and post testing was 0.65 ± 1.96 (BL= 8.11 ± 2.99, Post= 8.76 ± 3.75). The average time per awakening, in minutes, had a mean difference of –0.23 ± 0.97 minutes (BL= 2.58 ± 0.82, Post= 2.35 ± 0.46). The average wakefulness after sleep onset, in minutes, had a mean difference of 2.03 ± 8.40 (BL= 20.99 ± 8.65, Post= 23.01 ± 11.56).

The activPAL recorded the average sleep per night, and there was a mean difference of 22.55 ± 38.89 minutes (BL= 513.41 ± 55.49, Post= 535.97 ± 58.97).

The perceived sleep quality was measured at baseline and post intervention through the completion of the SQS, and a mean difference of 1.10 ± 6.03 was recorded (BL= 24.90 ± 11.28, Post= 26.00 ± 7.51). See table 3 for descriptive statistics of measured and perceived sleep and results of paired samples t-tests.

Table 3. Measured and Perceived Sleep (N=10)

	Baseline	Post	Mean Difference	t-value	p-value
ActiGraph					
Average time in bed (min)	358.90 ± 106.20	398.99 ± 100.58	40.04 ± 78.36	-1.618	.140
Average total sleep time (min)	337.91 ± 107.09	407.81 ± 159.48	69.90 ± 162.34	-1.362	.206
Average sleep efficiency (%)	93.51 ± 4.26	93.94 ± 4.22	0.44 ± 3.13	-0.439	.671
Average number of awakenings	8.11 ± 2.99	8.76 ± 3.75	0.65 ± 1.96	-1.053	.320
Average time per awakening (min)	2.58 ± 0.82	2.35 ± 0.46	-0.23 ± 0.97	0.745	.475
Average Wakefulness after sleep onset (min)	20.99 ± 8.65	23.01 ± 11.56	2.03 ± 8.40	-0.763	.465
activPAL					
Average Sleep per night (min)	513.41 ± 55.49	535.97 ± 58.97	22.55 ± 38.89	-1.834	.100
Perceived Sleep Quality					
SQS (0-86, 86 indicates poor quality)	24.90 ± 11.28	26.00 ± 7.51	1.10 ± 6.03	0.577	.578

Note. Values are presented in mean ± standard deviation for continuous variables and in percentage for categorical variable(s); * Less than 0.05 indicates statistical significance.

In table 4, the activity and energy expenditure data are reported from both ActiGraph and activPAL devices. The ActiGraph records average daily steps, with a mean difference of 1233.34 ± 2455.65 steps (BL= 6010.38 ± 1650.88, Post= 7244.02 ± 1650.88). The total step count over 6 days had a mean difference of 3819.60 ± 3684.73 and a p-value of 0.010 which indicates statistical significance and a p-value of –3.278 (BL= 40692.10 ± 9173.71, Post= 44511.70 ± 9460.42). The average daily METs had a mean difference of –0.02 ± 0.07 METs (BL= 1.36 ± 0.16, Post= 1.34 ± 0.10). Daily light activity, in minutes, had a mean difference of –80.73 ± 112.67 with a p-value of 0.050 which indicates statistical significance and a t-value of 2.266 (BL= 1066.96 ± 153.19, Post= 986.23 ± 114.45). Daily moderate activity had a mean difference of 19.63 ± 31.81 minutes (BL= 199.48 ± 65.98, Post= 219.11 ± 64.26). Daily vigorous activity had a mean difference of –11.22 ± 24.44 minutes (BL= 11.22 ± 24.44, Post= 0 ± 0). Daily very vigorous activity had a mean difference of –0.78 ± 2.48 minutes (BL= 0.78 ± 2.48, Post= 0 ± 0). Daily average hourly kcals had a mean difference of –43.37 ± 83.92 kcals (BL= 103.96 ± 81.78, Post= 60.59 ± 13.57).

The activPAL device data is also represented in table 4. The average daily steps had a mean difference of 469.67 ± 557.58 steps with a p-value of 0.026 indicating statistical significance and a t-value of –2.664 (BL= 2588.50 ± 965.14, Post= 3058.17 ± 1083.63). The total step count had a mean difference of 2872.80 ± 3707.50 steps with a p-value of 0.037 indicating statistical significance and a t-value of –2.450 (BL= 15279.80 ± 5866.95, Post= 18152.60 ± 6747.15). The average sedentary time had a mean difference of 23.19 ± 73.79 minutes (BL= 578.61 ± 165.82, Post= 601.79 ± 162.68). The average upright time had a mean difference of 21.97 ± 40.20 minutes (BL= 182.43 ± 81.72, Post= 204.40 ± 87.86). The average stepping time had a mean difference of 5.89 ± 7.11 with a t-value of 0.028 which indicates statistical significance and a t-value of –2.622 (BL= 36.10 ± 13.84, Post= 41.99 ± 15.91). See table 4 for descriptive statistics of activity and energy expenditure and results of paired samples t-tests.

Table 4. Activity and Energy Expenditure (N=10)

	Baseline	Post	Mean Difference	t-value	p-value
ActiGraph					
Average daily steps (steps)	6010.38 ± 2124.30	7244.02 ± 1650.88	1233.34 ± 2455.65	-1.589	.147
Total step count (steps)	40692.10 ± 9173.71	44511.70 ± 9460.42	3819.60 ± 3684.73 *	-3.278	.010
Average daily METs (METs)	1.36 ± 0.16	1.34 ± 0.10	-0.02 ± 0.07	0.637	.540
Daily light activity (min)	1066.96 ± 153.19	986.23 ± 114.45	-80.73 ± 112.67 *	2.266	.050
Daily moderate activity (min)	199.48 ± 65.98	219.11 ± 64.26	19.63 ± 31.81	-1.951	.083
Daily vigorous activity (min)	11.22 ± 24.44	0 ± 0	-11.22 ± 24.44	1.451	.181
Daily very vigorous activity (min)	0.78 ± 2.48	0 ± 0	-0.78 ± 2.48	1.000	.343
Daily average hourly kcals (kcals)	103.96 ± 81.78	60.59 ± 13.57	-43.37 ± 83.92	1.634	.137
activPAL					
Average daily steps (steps)	2588.50 ± 965.14	3058.17 ± 1083.63	469.67 ± 557.58 *	-2.664	.026
Total step count (steps)	15279.80 ± 5866.95	18152.60 ± 6747.15	2872.80 ± 3707.50 *	-2.450	.037
Average Sedentary time (min)	578.61 ± 165.82	601.79 ± 162.68	23.19 ± 73.79	-0.994	.346
Average upright time (min)	182.43 ± 81.72	204.40 ± 87.86	21.97 ± 40.20	-1.728	.118
Average stepping time (min)	36.10 ± 13.84	41.99 ± 15.91	5.89 ± 7.11 *	-2.622	.028

Note. Values are presented in mean ± standard deviation for continuous variables and in percentage for categorical variable(s); * Less than 0.05 indicates statistical significance.

DISCUSSION

The purpose of this study was to explore the relationship between exercise and quality of sleep in older adults in rural communities. It aimed to identify the effect of hybrid style exercise sessions on overall quality of sleep. Several significant relationships were found, suggesting more movement in each of the participants throughout the day, and some negative relationships on the type of activity they were involved in. There was a general lack of significance in the rest of the data we observed.

Functional Fitness Testing

The results of the study showed no significant difference in the functional fitness test from the beginning to the functional fitness test at the end. We did notice that the use of the functional fitness test was a good way for us to measure their beginning and ending progress from the exercise protocol. These exercises were completed in this study, measuring the flexibility and power in participants. In one study, the participants completed only five items from the functional fitness test. These tests included the 8-Foot Up-and-Go, a test of physical agility and dynamic balance; the Chair Stand test, which assessed lower body muscle strength and endurance; the Arm Curl test, which assessed arm muscle strength endurance, specifically of the biceps; the Chair Sit-and-Reach, a test of lower body flexibility; and the Back Scratch

Test, which assessed upper body flexibility, particularly of the shoulders[1].

Exercise Sessions

Participants in this study completed three exercise sessions per week. One day would include an in-person exercise session from one of the researchers. The other two days would include either a synchronous or an asynchronous exercise video, which was played at the Augusta Senior Center. These sessions lasted approximately 60 minutes and included a 10-minute dynamic warm-up, followed by a 30–40-minute exercise session, and then concluded with a 10-minute static cool-down with any remaining questions. Similarly, a 12-week exercise intervention for 12 participants who were rural adults (age=61± 9 years) and cancer survivors who felt cancer related fatigue (CRF) participated in a synchronous exercise intervention. The first two exercise sessions were held supervised by a physical therapist, and one exercise session during intervention was synchronous. Surveys were completed by participants every two weeks to assess their understanding of their current exercise program, and if participants indicated a need through the surveys, more in-person sessions were implemented. Physical assessments were completed before and after the intervention. The feasibility of the 12-week program was determined by attendance, survey completion, and program completion. As a result, 9 participants competed in the program with a 100% attendance rate and showed a significant improvement in reducing fatigue scores in CRF participants[15].

Quality of Sleep

The participants' assessments showed no significant improvement in their sleep quality as shown on the ActiGraph devices, activPAL devices, or the sleep quality scale. According to an article that describes the use of accelerometers as a reliable way to test sleep data and quality of sleep[12], this was consistent with this study, since participants wore the devices and filled out a sleep log each day and night they wore the devices. Looking at the data collected in this study, and how there is no significant significance in sleep quality, is contrary to the article, where there was an improvement in sleep quality and other sleep-related conditions throughout the study[2]. Looking at the results of sleep quality based on the sleep quality scale, there was also no significant improvement in the scores from the first assessment to the last assessment. One study looked at the correlation between sleep habits and cognitive function in adults over 65 years who lived in a rural community and concluded that poor sleep can be due to sleep disturbances, daytime dysfunctions, or other hypnotic drugs that can affect sleep is related to cognitive function[16].

Considerations

Significant differences were found in participants' total step count on both the ActiGraph and activPAL devices improved and average daily steps (469.67 ± 557.58) and average stepping time (5.89 ± 7.11). These variables are important because there is strong evidence that physically active older adults have higher levels of functional health, lower risks of falling, and improved cognitive

health[17]. Participants' daily light physical activity had a decrease that was statistically significant (-80.73 ± 112.67). This could be a result of participants having higher moderate physical activity levels which were trending in a positive direction (19.63 ± 31.81). The Center for Disease Control and Prevention recommends at least 150 minutes of moderate intensity a week for older adults over 65 years old[18].

Although there were no statistically significant differences in sleep quality between pre and post intervention, the activPAL device was trending towards significance for average sleep per night. Healthy sleep is a factor in predicting mental well-being, increased ability to perform activities of daily living, reduced fall risk, reduced risk of hospitalization and many more[19]. This was also shown through the 8 foot up-and-go trend towards significance (-0.61 ± 1.00), which will predict agility. Also trending towards significance was hand grip strength. A functional fitness assessment using a dynamometer measured hand exertion which can provide information about overall health and physical function. A study evaluated 4,095 participants intrinsic capacity, self-rated health, and hand grip strength. As a result, participants with poor handgrip strength had a higher risk of all-cause mortality, showing that handgrip strength can be a predictor of aspects of health in community-dwelling older adults[16].

During the pilot study, there weren't significant differences in sleep quality between participants at baseline and post-intervention. In future studies, a larger sample size would be recommended and ensuring attendance is necessary to participate in the study may contribute to further results. Ensuring participants of the importance of their sleep quality and the sleep quality scale could have led to more careful answers during both interventions. Overall, participating in physical activity for older adults is effective in improving sleep quality, blood pressure, brain health, and independent living[18].

Strengths and Limitations

Compared to previous research we had the same size sample. We had a total of 10 participants that were included in our research. The previous study included 10 participants. A larger sample size would have been beneficial to this study, but we were only able to recruit 10 due to the smaller size of the senior center.

The ActiGraph and activPAL were appropriate tools used to measure sleep quality and activity. Both devices have research behind them showing their validity. The ActiGraph collected sleep data including quantity of sleep hours per night, number of awakenings, duration of awakenings per minute, and sleep efficiency %. The activPAL was used to measure postural changes such as sitting standing, lying down and stepping. The activPAL devices have been found to overestimate sleep time by determining the start of sleep before it begins and estimating wake-up times to be later than reality. This could have affected our results by increasing sleep time. A sleep log was used as well for

participants to log when they went to sleep and when they woke up to aid in the data mining process.

The tools used were appropriate for this research but there were some flaws. The activPAL, as discussed earlier, has been found to overestimate sleep time which could have skewed our results. As for the sleep logs, some participants forgot to fill them out or mark down important information which made it difficult to sort through data. We also did not take attendance when starting the workout session and some participants did miss classes. We also had prerecorded videos that participants used for a week while we were gone, which takes out the accountability piece. Since we weren't on zoom or in person with them that week, they may not have challenged themselves in the workout. As for our synchronous zoom workouts there were technical difficulties at times including cameras not turning on and volume issues. This could have affected the intensity of the workout as well.

CONCLUSION

Participants exhibited a significant increase in daily steps showing enhanced levels of physical activity that are important for maintaining functional health. The notable rise in moderate physical activity along with a decrease in light activity suggests a shift in how participants engaged in their daily activities possibly leading to improved health. Although the study didn't find statistically significant changes in overall sleep quality, the observed data trends towards increased average sleep duration indicate a positive direction that could lead to future studies. Healthy sleep patterns are essential for cognitive function, emotional wellbeing and the ability to perform daily activities, making this an important area for future research. The improvements in the 8 foot up and go test suggest that the intervention may enhance mobility and reduce fall risk which is a significant concern for older adults. The trending positive outcomes in grip strength are associated with better overall health and lower mortality rates in older populations.

Overall, these findings reinforce the importance of implementing exercise and education programs for older adults. By promoting increased physical activity, improving sleep patterns, and improving functional fitness, these interventions can significantly contribute to the quality of life and longevity in this demographic. In a future study we would like to compare how exercising in a group versus exercising alone affects quality of sleep. We saw that this group of participants became close and showed up for each other as well as pushed themselves by competing with each other. We want to see how the social aspects of exercising in a group compare to working out one on one and effect quality of sleep.

ACKNOWLEDGEMENTS

The authors acknowledge the study participants for donating their time and contributions to the project, as well as the Augusta Senior Center for their facilities, the WEDC small research grant to purchase exercise equipment, and the Yoga Room for equipment use.

ADDRESS FOR CORRESPONDENCE

Braun, SI, PhD, University of Wisconsin-Eau Claire, 105 Garfield Ave. Eau Claire, WI, 54702, USA; Phone: 715-836-3774; FAX: 715-836-4074; Email: braunsi@uwec.edu.

REFERENCES

1. Vanderlinden, J., Boen, F., & van Uffelen, J. G. Z. (2020). Effects of physical activity programs on sleep outcomes in older adults: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity, 17*(11), 1–15.
2. Gupta, S., Bansal, K., & Saxena, P. (2022). A clinical trial to compare the effects of aerobic training and resistance training on sleep quality and quality of life in older adults with sleep disturbance. *Sleep Science*, 15(2), 188–195.
3. Blackford, K., Jancey, J., Lee, A. H., James, A. P., Howat P., A. P., & Anderson, A. (2015). A randomised controlled trial of a physical activity and nutrition program targeting middle-aged adults at risk of metabolic syndrome in a disadvantaged rural community. BMC Public Health, 15(1), 1-7.
4. Herbert, J., Schumacher, T., Brown, L. J., Clarke, E. D., & Collins, C. E. (2023). Delivery of telehealth nutrition and physical activity interventions to adults living in rural areas: A scoping review. *International Journal of Behavioral Nutrition and Physical Activity, 20*, 110.
5. Gell, N. M., Dittus, K., Caefer, J., Martin, A., Bae, M., & Patel, K. V. (2024). Remotely delivered exercise to older rural cancer survivors: A randomized controlled pilot trial. *Journal of Cancer Survivorship: Research and Practice, 18*(2), 596–605.
6. Aslan, G. (2024). An investigation of the relationship between frailty and life satisfaction in individuals aged 65 and over. *International Journal of Caring Sciences, 17*(1), 269–280.
7. Shah, A. R., Ni, L., Bay, A. A., Hart, A. R., Perkins, M. M., & Hackney, M. E. (2023). Remote versus in-person health education: Feasibility, satisfaction, and health literacy for diverse older adults. *Health Education & Behavior, 50*(3), 369–381.
8. Casals, C., Avila-Cabeza-de-Vaca, L., Gonzalez-Mariscal, A., Marin-Galindo, A., Costilla, M., Ponce-Gonzalez, J. G., Vazquez-Sanchez, M. A., & Corral-Perez, J. (2023). Effects of an educational intervention on faility status, physical function, physical activity, sleep patterns, and nutritional status of older adults with frailty of pre-frailty; the FRAGSALUD study. *Frontiers in Public Health, 11*(1267666), 1-14.
9. Wang, E., Keller, H., Mourtzakis, M., Rodrigues, I. B., Steinke, A., Ashe, M. C., & Giangregorio, L. (2022). MoveStrong at home: A feasibility study of a model for remote delivery of functional strength and balance training combined with nutrition education for older pre-frail and frail adults. *Applied Physiology, Nutrition, and Metabolism, 47*(12), 1172–1186.
10. Centers for Disease Control and Prevention. (2024, May). *About Rural Health*. Centers for Disease Control and Prevention.
11. van Hees, V. T., Sabia, S., Jones, S. E., Wood, A. R., Anderson, K. N., Kivimäki, M., Frayling, T. M., Pack, A. I., Bucan, M., Trenell, M. I., Mazzotti, D. R., Gehrman, P. R., Singh-Manoux, B. A., & Weedon, M. N. (2018). Estimating sleep parameters using an accelerometer without sleep diary. Scientific Reports, 8(1), 1-11.
12. Leister, K. R., Garay, J., & Barreira, T. V. (2022). Validity of a novel algorithm to detect bedtime, wake time, and sleep time in adults. *Journal for the Measurement of Physical Behaviour, 5*(2), 76-84.
13. Rikli R. E. & Jones C. J. (2013). Development and validation of criterion-referenced clinically relevant fitness standards for maintaining physical independence in later years. *Gerontologist*. *53*(2), 255-267.
14. Marker, R., Kittelson, A., Scorsone, J., Moran, I., Peters, J., & Leach, H. (2023). Feasibility and Preliminary Effectiveness of an Exercise Program For Rural Survivors of Cancer With Fatigue. *Archives of Physical Medicine and Rehabilitation*, *104*(3), e31.
15. Zhang, M., Liu, M., Guo, W., Chang, Y., Zhao, S., & Zhang, L. (2025). A study of the predictive value of different health indicators on the risk of all-cause mortality in older adults living in communities. *Geriatric Nursing, 61*, 106–112.
16. Tudor-Locke, C., Craig, C. L., Aoyagi, Y., Bell, R. C., Croteau, K. A., De Bourdeaudhuij, I., Ewald, B., Gardner, A. W., Hatano, Y., Lutes, L. D., Matsudo, S. M., Ramirez-Marrero, F. A., Rogers, L. Q., Rowe, D. A., Schmidt, M. D., Tully, M. A., & Blair, S. N. (2011). How many steps/day are enough? For older adults and special populations. *International Journal of Behavioral Nutrition and Physical Activity*, *8*(1), 80.
17. Centers for Disease Control and Prevention. (2024, March 25). *Physical Activity Benefits for Adults 65 or Older*. Physical Activity Basics.
18. Dzierzewski, J. M., & Dautovich, N. D. (2018). Who Cares about Sleep in Older Adults? *Clinical Gerontologist*, *41*(2), 109–112.