

ORIGINAL ARTICLE

Exercise for Everyone: A Randomized Controlled Trial of Project Workout on Wheels in Promoting Exercise Among Wheelchair Users



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Abstract

Objective: To compare the effectiveness of 2 home-based behavioral interventions for wheelchair users to promote exercise adoption and maintenance over 12 months.

Design: Randomized controlled trial, with participants stratified into groups based on disability type (stable, episodic, progressive) and support partner availability.

Setting: Exercise occurred in participant-preferred locations (eg, home, recreation center), with physiological data collected at a university-based exercise laboratory.

Participants: Inactive wheelchair users (N=128; 64 women) with sufficient upper arm mobility for arm-based exercise were enrolled. Participants on average were 45 years of age and lived with their impairment for 22 years, with spinal cord injury (46.1%) most commonly reported as causing mobility impairment.

Interventions: Both groups received home-based exercise interventions. The staff-supported group (n=69) received intensive exercise support, while the self-guided group (n=59) received minimal support. Both received exercise information, resistance bands, instructions to self-monitor exercise, regularly scheduled phone calls, and handwritten cards.

Main Outcome Measures: The primary outcome derived from weekly self-reported exercise. Secondary outcomes included physical fitness (aerobic/muscular) and predictors of exercise participation.

Results: The staff-supported group reported significantly greater exercise (~17min/wk) than the self-guided group over the year ($t=10.6$, $P=.00$), with no significant between-group difference in aerobic capacity ($t=.76$, $P=.45$) and strength ($t=1.5$, $P=.14$).

Conclusions: Although the staff-supported group reported only moderately more exercise, the difference is potentially clinically significant because they also exercised more frequently. The staff-supported approach holds promise for encouraging exercise among wheelchair users, yet additional support may be necessary to achieve more exercise to meet national recommendations.

Archives of Physical Medicine and Rehabilitation 2014;95:20-8

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Presented to the Disability Section of the American Public Health Association, November 1, 2011, Washington, DC.

Froehlich-Grobe was affiliated with the University of Kansas during the data collection phases, moving to the University of Texas in the final study year when data analyses occurred.

Supported by the National Institute of Child Health and Human Development/National Institutes of Health (grant no. R01 HD048628) and in part by a CTSA grant initially from NCR and now from NCATS awarded to the University of Kansas Medical Center for Frontiers: The Heartland Institute for Clinical and Translational Research # UL1TR000001 (formerly # UL1RR033179). The contents are solely the responsibility of the authors and do not necessarily represent the official views of the National Institutes of Health, National Institute of Child Health and Human Development, or National Center for Medical Rehabilitation Research.

No commercial party having a direct financial interest in the results of the research supporting this article has conferred or will confer a benefit on the authors or on any organization with which the authors are associated.

Clinical Trial Registration No.: NCT00866112.

Nearly 1 in 5 Americans lives with a disability,¹ and this is expected to increase.² Persons with disabilities are significantly more likely to be sedentary and less likely to be active³⁻⁵—a troubling health disparity given the substantial health benefits of an active lifestyle,^{6,7} which may be greater for those with disabilities than the general population^{7,8} because they experience a higher incidence⁹ and prevalence¹⁰ of numerous chronic health conditions. Barriers to being physically active are compounded for those with mobility impairments. In addition to general exercise barriers (eg, motivation, time), they face numerous unique disability-related barriers (eg, lack of affordable/accessible transportation, knowledgeable health professionals, and accessible equipment and facilities).¹¹⁻¹⁴ Those with severe mobility impairments (eg, spinal cord injury [SCI]) also face equipment, resource, and environmental barriers to being active. While strong evidence shows exercise has specific health and functional benefits for people with disabilities,^{8,15} data regarding effective strategies for adopting and maintaining an active lifestyle despite disabilities are limited and conflicting. For example, some studies have reported minimal or no effects on physical activity or exercise^{16,17} while other studies have reported significant increases in physical activity or exercise.¹⁸⁻²³

Successful interventions have used different behavioral approaches, including phone calls to support activity efforts.^{18,20-23} While the frequency and content of calls has varied,^{18,20,21} they focus on developing specific goals,^{19,22,23} providing support,^{18,20,21} and addressing barriers.^{19,20,22} Based on this evidence and the results of our pilot study,¹⁹ which found that individual counseling/education increased physical activity in mobility-impaired women, we designed a theory-based, multi-component 52-week intervention to compare the effectiveness of 2 home-based interventions designed to increase the adoption and maintenance of home- and community-based exercise among manual wheelchair users. Secondarily, we examined factors associated with exercise adherence.

We hypothesized that (1) the staff-supported experimental group would engage in significantly more aerobic and strength exercise at 12 and 52 weeks compared with the self-guided comparison group; (2) the experimental group would demonstrate significantly greater increases in aerobic capacity and muscular strength than the comparison group; and (3) exercise adherence would be greatest for those reporting fewer barriers, higher exercise self-efficacy, fewer health problems, less pain, and less fatigue.

Methods

Theoretical framework

The multicomponent intervention was based on social cognitive theory^{24,25} and the relapse prevention model.^{26,27} Intervention components included building self-efficacy and behavioral skills using strategies successfully applied in the general population and

listed by the U.S. Task Force on Community Preventive Services (the Community Guide)²⁸ as effective for promoting exercise: goal setting, self-monitoring, building social support, and preventing relapse. The 12-month study had a 6-month intervention period and a 6-month follow-up.

Recruitment and eligibility

We previously published details of the recruitment methods.²⁹ Strategies included posting fliers, advertising, and giving presentations at community events. Participants were offered a \$10 gift card for referring others.

Telephone screening assessed the following inclusion criteria: (1) an impairment for ≥ 6 months necessitating manual or powered wheelchair use for mobility outside the home; (2) age between 18 and 65 years; (3) not currently physically active (< 150 min/wk of moderate or vigorous exercise); (4) sufficient upper arm mobility for aerobic exercise; and (5) physician approval. Exclusion criteria were as follows: (1) body mass index ≥ 50 ; (2) physician-identified contraindications for unsupervised exercise; (3) cognitive impairment precluding self-directing daily activities; and (4) current or planned pregnancy.

Recruitment/enrollment into 10 cohorts occurred over 3 years. Of 323 screened individuals, 173 were eligible (fig 1). Thirty-eight declined participation and 135 enrolled. The initial 7 participants served to pilot the intervention and methods and were excluded from subsequent analyses. All had physician clearance and provided written informed consent, approved by the Human Subjects Committee (IRB no. 10053).

Randomization

Eligible participants were randomly assigned to either the staff-supported intervention group or the self-guided comparison group after stratification on the availability of a partner to support their effort to increase exercise (yes/no) and their disability type (stable, episodic, or progressive).

Statistical power

An a priori power calculation on the primary outcome (self-reported aerobic exercise in minutes per week) indicated that a sample size of 104 (52 per group) was required for 80% power, with a conservatively assumed high correlation of .60 among repeated measures, a moderate group difference (Cohen's $d = .50$), and an anticipated attrition rate of 16%. This is considerably smaller than differences (median $d = .69$) observed in a previous pilot study¹⁹ and similar published studies,³⁰⁻³² suggesting adequate power for the final sample of 128 participants.

Interventions

Elements common to both groups

Protocol and intervention details were previously published.³³ Briefly, both groups received (1) disability-specific educational information (health benefits of exercise, aerobic and strength training distinctions, accessible exercises and locations); (2) resistance bands; (3) instruction/encouragement for self-monitoring; (4) 15 regularly scheduled calls; and (5) hand-written cards for birthdays, holidays, and major events. The goal

List of abbreviations:

| | |
|-------|-------------------------------------------------|
| ACSM | American College of Sports Medicine |
| AIC | Akaike information criterion |
| HR | heart rate |
| SCI | spinal cord injury |
| SRAHP | Self-Rated Abilities for Health Practices Scale |
| THR | target heart rate |

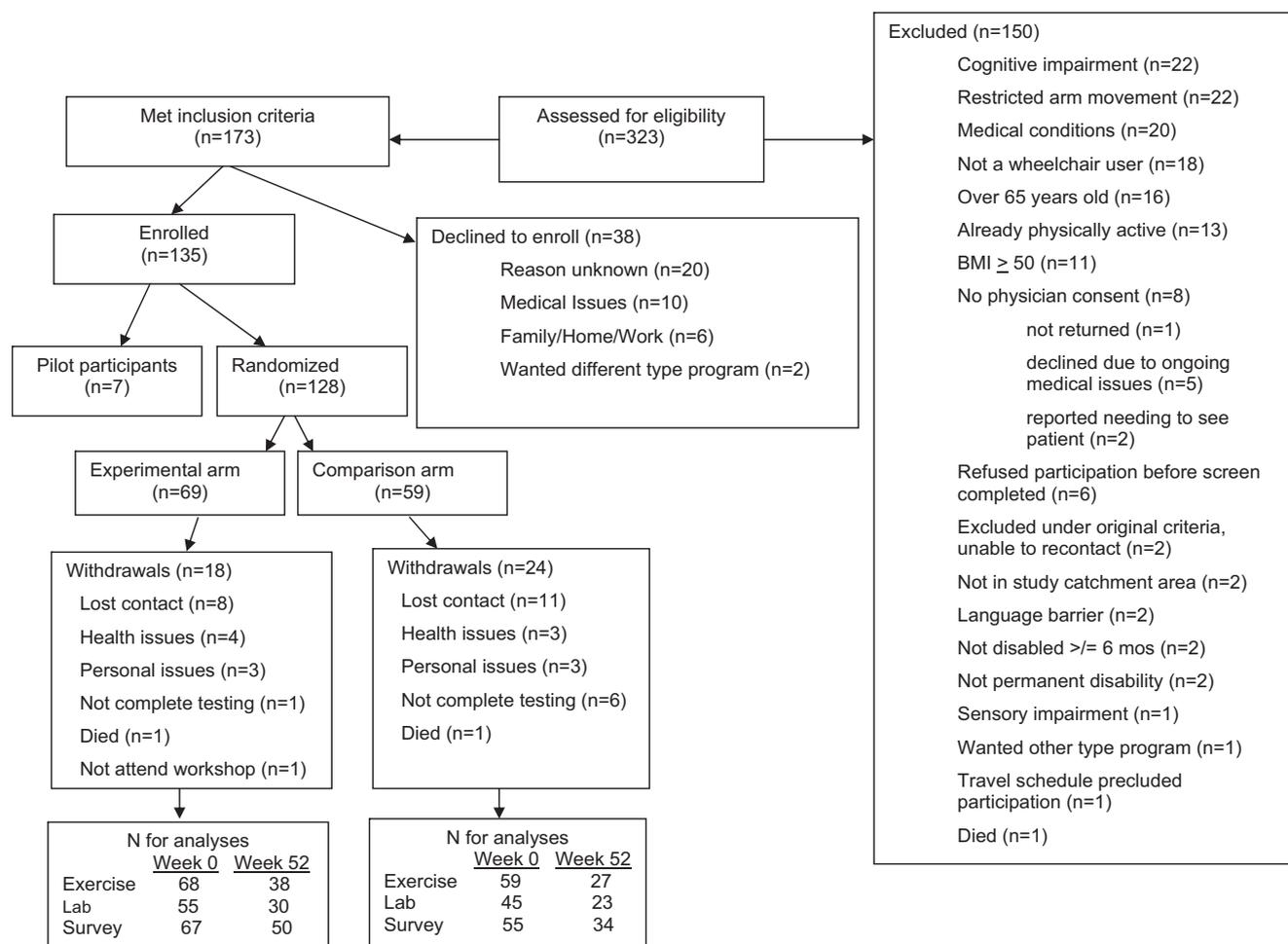


Fig 1 The Consolidated Standards of Reporting Trials (CONSORT) flow chart. Abbreviation: BMI, body mass index.

was to increase exercise either at home or at another self-selected location while maximizing options to deal with individual limitations, enjoyment, and schedules. Support intensity, described below, was the primary difference between groups.

All participants were provided an individual target heart rate (THR) for adopting moderate-intensity aerobic exercise. THR was prescribed at 55% to 75% of heart rate reserve³⁴ plus resting heart rate (HR). Peak HR was the highest HR observed during the peak aerobic capacity test described below. For participants without medical clearance to perform this test, peak HR for prescribing THR was estimated as follows: peak HR = 220 – age (y).

Intervention for staff-supported experimental group

Intervention components designed to increase exercise knowledge, self-efficacy, and self-management skills included attending a 1-day educational workshop, during which individualized exercise plans were developed for setting specific exercise goals, establishing plans to prevent relapses, and identifying people to support exercise efforts. Study staff phone calls to participants also provided support for participants' exercise efforts (phone calls were completed weekly for 2mo, biweekly the next 2mo, and monthly for months 5 and 6). Callers addressed 11 topics during 15 scheduled calls, with flexibly designed scripts to

maximize meeting individual experiences and needs (specific topics are described elsewhere³³). Participants received a monthly 2-page newsletter for the year. Participants unable to attend the workshop received a DVD containing workshop content and developed their exercise plan during the initial support call.

Intervention for self-guided comparison group

The self-guided comparison group received a minimal-contact intervention that included 15 phone calls that were similarly scheduled as those for the staff-supported group. Educational materials mailed to participants were reviewed during the first phone call. Subsequent calls were limited to thanking or requesting return of logs and inquiring about exercise-related injuries.

Outcome measures

The primary study outcome was self-reported weekly minutes of aerobic exercise, reported weekly for 52 weeks. Secondary outcomes included peak aerobic capacity and maximal strength. All staff members completing fitness evaluations were blinded to group assignment.

Table 1 Participant demographics

| Variable | Full Sample | | | Staff-Supported Intervention Group | | | Self-Guided Comparison Group | | |
|--------------------------------------|-------------|------|------|------------------------------------|------|------|------------------------------|------|------|
| | N | M | SE | n | M | SE | n | M | SE |
| Age (y) | 128 | 44.5 | 1.1 | 69 | 46.0 | 1.5 | 59 | 42.9 | 1.7 |
| Years living with disability | 124 | 22.3 | 1.4 | 66 | 23.3 | 2.0 | 58 | 21.0 | 2.1 |
| Age at disability onset (y) | 124 | 22.4 | 1.6 | 66 | 22.9 | 2.1 | 58 | 21.7 | 2.6 |
| Disability severity | 122 | 7.6 | 0.5 | 67 | 7.0 | 0.6 | 55 | 8.5 | 0.7 |
| Exercise at week 0 | | | | | | | | | |
| Aerobic exercise (min/wk) | 127 | 23.7 | 5.7 | 68 | 25.0 | 8.5 | 59 | 22.1 | 7.4 |
| Aerobic exercise (d/wk) | 127 | 0.8 | 0.1 | 68 | 0.7 | 0.2 | 59 | 0.9 | 0.2 |
| Resistance exercise (d/wk) | 127 | 0.9 | 0.2 | 68 | 0.8 | 0.2 | 59 | 1.1 | 0.2 |
| Fitness | | | | | | | | | |
| V _{o2} peak (mL/kg/min) | 100 | 13.2 | 0.4 | 55 | 12.7 | 0.6 | 45 | 13.8 | 0.6 |
| Strength (kg) | 97 | 69.3 | 2.9 | 55 | 65.1 | 3.8 | 42 | 74.8 | 4.5 |
| Body weight (kg) | 127 | 86.7 | 2.3 | 68 | 83.0 | 2.7 | 59 | 90.9 | 3.9 |
| Fatigue* | 122 | 72.7 | 2.2 | 67 | 72.0 | 2.8 | 55 | 73.6 | 3.4 |
| Bodily pain [†] | 122 | 56.7 | 2.3 | 67 | 57.7 | 3.3 | 55 | 55.4 | 3.1 |
| Total exercise barriers [‡] | 122 | 29.6 | 0.6 | 67 | 29.4 | 0.9 | 55 | 29.9 | 0.7 |
| Exercise self-efficacy [§] | 122 | 22.1 | 0.4 | 67 | 22.6 | 0.5 | 55 | 21.5 | 0.6 |
| | | n | % | n | % | | n | % | |
| Sex | 128 | | | | | | | | |
| Male | | 64 | 50 | 38 | 55.1 | | 26 | 44.1 | |
| Female | | 64 | 50 | 31 | 45.9 | | 33 | 55.9 | |
| Race/ethnicity | 128 | | | | | | | | |
| White | | 102 | 79.7 | 52 | 75.4 | | 50 | 84.7 | |
| Black | | 15 | 11.7 | 10 | 14.5 | | 5 | 8.5 | |
| Multiracial | | 8 | 6.3 | 5 | 7.2 | | 3 | 5.1 | |
| Other | | 3 | 2.3 | 2 | 2.9 | | 1 | 1.7 | |
| Education | 122 | | | | | | | | |
| ≥High school | | 27 | 22.1 | 15 | 22.7 | | 12 | 21.4 | |
| Some college/bachelor's degree | | 63 | 51.6 | 32 | 48.5 | | 31 | 55.4 | |
| Some graduate/graduate degree | | 32 | 26.2 | 19 | 28.8 | | 13 | 23.2 | |
| Employment | | | | | | | | | |
| Employed (full/part) | 121 | 44 | 36.4 | 26 | 40.0 | | 18 | 32.1 | |
| Unemployed | | 47 | 38.8 | 25 | 38.8 | | 22 | 39.3 | |
| Student/retired/volunteer | | 30 | 24.8 | 14 | 21.5 | | 16 | 28.6 | |
| Primary disability | | | | | | | | | |
| SCI | | 59 | 46.1 | 35 | 50.7 | | 24 | 40.7 | |
| CP/SB | | 26 | 20.3 | 8 | 11.6 | | 18 | 30.5 | |
| MS | | 10 | 7.8 | 4 | 5.8 | | 6 | 10.2 | |
| Other | | 10 | 7.8 | 6 | 8.7 | | 4 | 6.8 | |
| Amputation | | 8 | 6.3 | 4 | 5.8 | | 4 | 6.8 | |
| Orthopedic | | 5 | 3.9 | 5 | 7.2 | | 0 | 0 | |
| Postpolio | | 4 | 3.1 | 2 | 2.9 | | 2 | 3.4 | |
| Fibromyalgia/lupus | | 3 | 2.3 | 2 | 2.9 | | 1 | 1.7 | |
| Stroke/TBI | | 3 | 2.3 | 3 | 4.3 | | 0 | 0 | |
| Health events reported (over 52wk) | | 8.5 | 10.4 | 69 | 8.7 | 10.4 | 59 | 8.2 | 10.4 |

Abbreviations: CP, cerebral palsy; M, mean; MS, multiple sclerosis; SB, spina bifida; TBI, traumatic brain injury; V_{o2}, oxygen consumption.

* Lee Fatigue Scale score.

[†] Medical Outcomes Study 36-Item Short-Form Health Survey score.

[‡] Barriers to Health Activities Among Disabled Persons score.

[§] SRAHP Scale score.

Demographic data collected at baseline included birth date, sex, race and ethnicity, mobility impairment etiology, impairment onset date, marital status, education, employment, health care coverage, and household income.

Participants reported weekly the type, duration, and frequency of aerobic exercise, including HR during aerobic exercise, whether they performed strength exercise, and the occurrence of disability-related health problems on standardized, preprinted

Table 2 Estimated means and SEs

| Variable | Staff-Supported Intervention Group | | | | | | Self-Guided Comparison Group | | | | | | | | | | | | | | | | | | |
|----------------------------------|------------------------------------|-----|--------|-----|---------|-----|------------------------------|-----|----------|-----|--------|-----|---------|-----|---------|-----|----------|-----|------|-----|------|-----|------|-----|-----|
| | Week 0 | | Week 1 | | Week 12 | | Week 26 | | Week 52 | | Week 0 | | Week 12 | | Week 26 | | Week 52 | | | | | | | | |
| | M | SE | M | SE | M | SE | M | SE | M | SE | M | SE | M | SE | M | SE | M | SE | | | | | | | |
| Exercise | | | | | | | | | | | | | | | | | | | | | | | | | |
| Aerobic exercise (min/wk) | 25.0 | 8.5 | 52.7 | 4.9 | 51.7 | 3.9 | 50.3 | 3.4 | 47.8 | 5.4 | 22.1 | 7.4 | 36.4 | 5.1 | 35.3 | 4.2 | 34.0 | 3.9 | 31.5 | 5.9 | .00 | .52 | | | |
| Aerobic exercise (d/wk) | 0.7 | 0.2 | 2.1 | 0.1 | 2.0 | 0.1 | 1.9 | 0.1 | 1.7 | 0.2 | 0.9 | 0.2 | 1.5 | 0.2 | 1.4 | 0.1 | 1.3 | 0.1 | 1.2 | 0.2 | .00 | .15 | | | |
| Resistance exercise (d/wk) | 0.8 | 0.2 | 2.0 | 0.1 | 1.9 | 0.1 | 1.8 | 0.1 | 1.6 | 0.2 | 1.1 | 0.2 | 1.7 | 0.1 | 1.6 | 0.1 | 1.5 | 0.1 | 1.3 | 0.2 | .02 | .09 | | | |
| Fitness | | | | | | | | | | | | | | | | | | | | | | | | | |
| Variable | Baseline | | 3mo | | 6mo | | 12mo | | Baseline | | 3mo | | 6mo | | 12mo | | Baseline | | 3mo | | 6mo | | 12mo | | |
| | M | SE | M | SE | M | SE | M | SE | M | SE | M | SE | M | SE | M | SE | M | SE | M | SE | M | SE | M | SE | |
| VO ₂ peak (mL/kg/min) | 12.7 | 0.6 | 13.6 | 0.6 | 13.3 | 0.6 | 13.3 | 0.6 | 13.3 | 0.6 | 13.3 | 0.6 | 13.3 | 0.6 | 14.3 | 0.7 | 13.9 | 0.7 | 13.9 | 0.7 | 13.9 | 0.6 | 13.9 | 0.6 | .45 |
| Maximal bench press strength lbs | 65.1 | 3.6 | 69.2 | 3.6 | 72.0 | 3.6 | 73.8 | 3.8 | 73.2 | 4.1 | 77.3 | 4.1 | 80.1 | 4.1 | 82.0 | 4.1 | 82.0 | 4.1 | 82.0 | 4.1 | 82.0 | 4.3 | 82.0 | 4.3 | .14 |
| Body weight (kg) | 83.5 | 3.1 | 83.5 | 3.1 | 83.5 | 3.1 | 83.5 | 3.1 | 83.5 | 3.1 | 83.5 | 3.1 | 83.5 | 3.1 | 91.4 | 3.3 | 91.3 | 3.3 | 91.3 | 3.3 | 91.3 | 3.4 | 91.3 | 3.4 | .09 |

NOTE. Raw means are reported for week 0.
 Abbreviations: M, mean; VO₂, oxygen consumption.
 * P value for group difference.
 † P value for weekly/monthly linear change (ie, increase or decrease), except for VO₂max (cubic change; ie, increase from baseline to 3mo, decrease from 3–6mo, and maintenance afterward) and strength (quadratic change; ie, rapid then slow increase).

logs, which had space for open-ended comments. We previously used this approach with mobility-impaired women. We provided reminders for late or missing logs and \$5 gift cards on 5 occasions for returning logs in postage-paid envelopes. On 3 occasions (months 3, 6, 9), participants wore an accelerator (ActiGraph model GT1M^a) on their wrist during all waking hours for 5 consecutive days to assess the validity of self-reported exercise.

Anthropometric data were collected at baseline and months 3, 6, and 12 in a medical center exercise laboratory. Participants were compensated for time and transportation. Protocol details, summarized below, were previously published.³³

Body weight was measured using an accessible Seca scale (model no. 664^b). Maximal strength was assessed with a 1-repetition maximum free weight bench press. Participants performed up to 5 lifts with increasing weight until they could not use proper technique or reported an inability to continue. Peak aerobic capacity was assessed during a graded, discontinuous arm crank test (2-min stages, workload increased 5–15W per stage depending on conditioning level) using a SciFit Pro I ergometer^c (50 revolutions/min). Oxygen consumption was assessed continuously using a Parvo-Medics' True One 2400 metabolic cart.^d Peak aerobic capacity was the highest oxygen consumption observed. The highest HR observed was used to calculate the THR. Blood pressure and heart rate (electrocardiogram) were monitored during all tests. A physician was present for participants at risk for cardiovascular events.

Self-reported perceptions of exercise and health were collected at baseline and months 3, 6, and 12. Surveys were mailed before every fitness appointment and returned at the appointment.

The Participation Survey³⁵ evaluates mobility-impaired individuals' participation in 5 daily life domains and was used for a disability severity index based on reporting assistance needed for 7 personal care activities (grooming, dressing, bathing, meal preparation, eating, bladder care, bowel care) from someone else and with assistive equipment. Responses (0, no help; 1, some help; 2, a lot of help) were summed over the 14 items; higher scores indicated greater severity. We observed high internal consistency ($\alpha = .81$ at baseline).

The 18-item Lee Fatigue Scale³⁶ measures perceived fatigue and has strong internal consistency ($\alpha = .91-.96$) across different populations^{36,37} and in our study sample ($\alpha = .87-.88$ across baseline, months 3, 6, 12). Two Medical Outcomes Study 36-Item Short-Form Health Survey³⁸ items asking how much bodily pain was present in the past 4 weeks and how much pain interfered with normal work comprised the bodily pain subscale. Internal consistency on this subscale was high to strong ($\alpha = .80-.91$). The 16-item Barriers to Health Activities Among Disabled Persons³⁹ assessed perceived exercise barriers with 2 subscales: motivation (7 items) and external barriers (9 items). It has high internal consistency ($\alpha = .82$) and good discriminant validity between individuals with and without disabilities,³⁹ which was also confirmed in this study ($\alpha = .76-.84$). The 7-item exercise subscale of the Self-Rated Abilities for Health Practices Scale (SRAHP)⁴⁰ measured exercise self-efficacy. Internal consistency for the SRAHP in our study was high ($\alpha = .79-.82$).

Treatment fidelity

Intervention delivery fidelity was assessed for workshop attendance, log return, phone call delivery, and appropriate provision (or not) of exercise support. Call tracking included number of calls attempted/completed, percent completed, and number and percent of scripted topics delivered (staff-supported group only).

Table 3 Best subset mixed modeling results for weekly aerobic exercise minutes

| Variable | Staff-Supported Intervention Group | | | Self-Guided Comparison Group | | |
|-----------------------------|------------------------------------|-------|----------|------------------------------|-------|----------|
| | β | SE | <i>P</i> | β | SE | <i>P</i> |
| Intercept | 90.34 | 29.86 | .004 | -43.81 | 25.59 | .093 |
| Years lived with disability | 0.15 | 0.45 | .740 | -0.04 | 0.39 | .917 |
| Month (linear change) | 1.08 | .97 | .264 | 1.35 | 0.88 | .132 |
| Health problems (count) | -0.27 | 1.15 | .814 | -1.28 | 0.86 | .137 |
| Fatigue* | -0.17 | 0.17 | .321 | 0.31 | 0.16 | .055 |
| Bodily pain† | 0.04 | 0.19 | .842 | | | |
| Total exercise barriers‡ | -1.74 | 0.77 | .025 | | | |
| Exercise self-efficacy§ | | | | 2.27 | 0.90 | .014 |

* Lee Fatigue Scale score.

† Medical Outcomes Study 36-Item Short-Form Health Survey score.

‡ Barriers to Health Activities Among Disabled Persons score.

§ SRAHP Scale score.

Data analyses

Primary analyses were longitudinal comparisons of outcomes between the 2 groups over exercise adoption (baseline to 12wk) and maintenance (13–52wk). To address hypotheses 1 and 2, we used mixed modeling to account for interdependency among observations collected at multiple time points. A proper error covariance structure was determined based on the model fit indicated by log-likelihood, Akaike information criterion (AIC), and Bayesian Information Criterion. Mixed modeling estimated the time-related (linear, quadratic, cubic, etc) changes and group differences in each outcome over the 12-month period.

Factors influencing intervention effectiveness were also assessed (hypothesis 3). Best subset mixed modeling analyses identified the best model for predicting weekly aerobic exercise minutes. We identified the best model separately for each group because initial analyses indicated significant group differences predicting aerobic exercise minutes. Potential predictors included demographic, peak aerobic capacity, disability-related, and psychosocial health variables, and health problems. Time-variant (linear) change was a priori selected as a covariate. A total of 2047 models ($2^m - 1$, where m is the number of potential predictors) could be constructed from the set of variables. Corrected AIC and minimal description length were compared across these 2047 models using the SAS macro ALLMIXED2.^{33,41,e}

The Actigraph (model GT1M) provided an objective measure of activity to validate our self-report exercise measure. We examined correlations between accelerometer-derived minutes of moderate/vigorous activity⁴² and minutes of moderate/vigorous activity in bouts of 10 minutes a day with self-reported log data.

All analyses were based on an intention-to-treat approach. Partial sets of outcome measurements were not lost but analyzed via restricted maximum likelihood estimation in the mixed models. Statistical significance was set at $\alpha = .05$; all analyses used SAS 9.3.^{43,e}

Results

The groups did not differ on sociodemographic characteristics, disability profiles, or health events (table 1). On average, participants were 45 years of age, lived with their disabling condition for 22 years, and needed little assistance with activities of daily living (disability severity, 7.7 on a 0–28 scale). Most at least attended some college (78%); only 36.4% were employed. SCI (46%) was the most common cause of impairment.

Retention

One third ($n = 42$) of participants withdrew or were lost to follow-up. While more withdrew from the self-guided (40.7%) than the staff-supported group (26.1%), this difference was not significant ($\chi^2 = 3.07$, $P = .08$). Dropouts (40.5 ± 11.4 y) were significantly younger than completers (46.5 ± 12.7 y) ($t = -2.6$, $P < .05$) but did not differ by sex, time with disability, height, weight, strength, or self-reported outcomes (all P values $> .05$).

Accelerometer data

Self-report exercise minutes were moderately correlated with accelerometer data: moderate activity minutes per day ($r = .43$, $P < .01$), vigorous activity minutes per day ($r = .31$, $P < .01$), and moderate or vigorous activity minutes per day in 10-minute bouts ($r = .48$, $P < .01$).

Self-reported exercise

Mixed modeling revealed significant group differences in exercise adoption and maintenance. The staff-supported group spent significantly more time (17min/wk more) and 0.5d/wk more in aerobic exercise over the first 12 weeks (adoption), and approximately 15min/wk more and 0.6d/wk more during weeks 13 to 52 (maintenance) compared with the self-guided group. Table 2 depicts average time (min/wk) and average number of days per week for aerobic and resistance training.

Physiological outcomes

There were significant within-group but not between-group differences for change in peak aerobic capacity and maximal strength over 12 months (see table 2). There were no significant between-group or within-group differences for change in body weight.

Predictors of exercise adherence and maintenance

Although the best subset mixed modeling results suggested time with disability, health problems, fatigue, bodily pain, exercise self-efficacy, and exercise barriers predicted exercise adoption and maintenance, the best fit for each group contained different variables (table 3). After accounting for other predictors, only exercise barriers (for staff-supported group) and exercise self-efficacy (for self-guided group) significantly predicted weekly minutes of aerobic exercise over 12 months.

Treatment fidelity

There were no between-group differences for number of calls attempted/completed or exercise logs returned (68.8% staff-supported vs 60.7% self-guided). Both groups completed two thirds of planned calls (66.9% staff-supported vs 63.5% self-guided).

Discussion

The evidence for effective strategies to promote exercise for people with disabilities is limited, with studies reporting varied success.^{16,18,20,21} Our study compared behavioral and physiological outcomes over 12 months between wheelchair users in a staff-supported or self-guided intervention group, where intensity of exercise support was the major distinguishing feature. Our intervention included empirically supported components for increasing exercise (ie, individualized counseling,¹⁹⁻²³ exercise goals,^{19,22,23} self-monitoring, ongoing phone-based support,^{22,23,33,34} and barrier problem solving^{20,22}). However, the magnitude of increase in exercise that we observed was lower than expected.

As hypothesized, both groups adopted exercise and significantly improved aerobic capacity and strength. Providing additional staff support resulted in increased aerobic exercise of only 17min/wk compared with the self-guided group (51 vs 34min/wk). While modest, the difference is potentially clinically significant because the staff-supported group also exercised more frequently, both each week (see aerobic/strength days, table 2) and over the year. Weekly exercise data reveal that more than half (61%) of staff-supported participants on average over the year reported some aerobic exercise each week compared with less than half (48%) of the self-guided group (data not shown). Although additional/different support may be necessary for wheelchair users to meet the activity guidelines of the American College of Sports Medicine⁴⁴ (ACSM; a minimum of 30min of moderate-intensity activity 5d/wk, or 20min of vigorous-intensity activity 3 times/wk, or an equivalent combination), recent evidence-based clinical guidelines indicate that individuals with SCI need only 40min/wk of moderate to vigorous exercise for fitness increases.⁴⁵ Notably, the staff-supported experimental participants achieved and maintained this level (average, 51min/wk), while the self-guided group fell short (average, 34min/wk).

To place these results in context, our staff-supported intervention increased exercise more than some other interventions for wheelchair users,^{16,17,23,46,47} although less than others.¹⁸⁻²⁰ Differences between our study and previous studies include a primary outcome of contemporaneous self-reports, combined with objective assessment (accelerometry). Other studies²⁰⁻²³ have used only retrospective self-reports, which have been shown to overestimate activity levels because of faulty recollection, erroneous perceptions, and social desirability bias.⁴⁸⁻⁵¹ For example, retrospective survey data from the National Health and Nutrition Examination Survey show that 60% of participants report meeting physical activity guidelines, whereas less than 5% met activity guidelines when assessed by accelerometer.⁵² Our study also found that retrospective estimates of physical activity, using the Behavioral Risk Factor Surveillance System physical activity module, yielded vastly higher values (over 300min/wk by 3 and 6mo) than the contemporaneous exercise logs (~51min/wk). Similar methodological issues may have occurred in other studies,^{18,20,21} where physical activity was based on self-reports of

time generally spent in physical activity^{20,21} or performed over 1 week,¹⁸ but used to represent a 3- to 6-month time frame in the absence of objective activity monitoring. Thus, while the levels of exercise in this study were less than those in some similar studies,¹⁸⁻²⁰ we argue that our exercise log data more likely reflect reality, and future studies investigating physical activity measurement validity and reliability for individuals with disabilities are warranted.

We encountered other methodologic issues worth noting. First, participants experienced substantial delays (mean \pm SE, 75.2 \pm 4.6d) between eligibility determination, when their motivation was likely highest, and program initiation. These delays primarily occurred to recruit sufficient participants for a cohort. Allowing participants to enter an ongoing program on eligibility determination could better capitalize on initial motivation. Second, many participants did not have access to, or familiarity with, accessible exercise equipment. Obtaining exercise equipment or locating a suitable exercise facility took time, and connecting individuals with options may facilitate better adoption.¹⁸ Third, workshop attendees expressed interest in reconnecting with one another, and others have found benefits from social interaction during structured exercise interventions.⁵³ Thus, including mechanisms that facilitate participant interaction may enhance individuals' adherence. Fourth, health problems hindered many from being as active as they hoped. Our 110 participants experienced 418 health events, including allergies, colds, influenza, and serious events requiring hospitalizations, surgeries, or extensive treatment. Strategies for such "down periods" might enhance exercise interventions for individuals with disabilities.

Study limitations

Despite adequately powered a priori, our study was underpowered with a sample size lower than expected. Although the attrition rate was similar to that in other studies, it was higher than estimated (~33%). However, dropouts were not significantly different than completers, as the latter included participants who maintained exercise and those who did not.

Conclusions

Exercise behavior is challenging to change. This staff-supported intervention demonstrated increased exercise adoption and maintenance that was significantly, but only moderately, greater than that with the self-guided approach. Significant increases in peak aerobic capacity and muscular strength were shown in both groups. Although the average minutes per week of aerobic exercise fell short of the ACSM guidelines for the general population⁴⁴ and those with SCI,⁵⁴ the staff-supported group met the new evidence-based guidelines for individuals with SCI.⁴⁵ This study contributes to the evidence base of approaches for promoting activity among those with disabilities. The staff-supported approach, which attempted to eliminate transportation and environmental barriers, holds promise for promoting aerobic exercise among wheelchair users. Yet, additional support may be necessary to achieve more weekly exercise. We observed participants making connections and sharing knowledge during workshops, and most expressed interest to reconnect. Incorporating strategies that facilitate peer support may further increase weekly exercise. The innovative use of technology such as computers/tablets/smartphones may help increase adoption through facilitating virtual social and professional support while

avoiding transportation barriers.⁵⁵ Others have successfully used peer support^{56,57} within Internet-based interventions promoting behavior change.

Suppliers

- a. ActiGraph, 49 E Chase St, Pensacola, FL 32502.
- b. Seca North American West Medical Scales and Measuring Systems, Seca Corp, 13601 Benson Ave, Chino, CA 91710.
- c. SciFit Corporate Headquarters, 5151 S 110th E Ave, Tulsa, OK 74146.
- d. ParvoMedics, 8152 South 1715 East, Sandy, UT 84093.
- e. SAS Institute Inc, 100 SAS Campus Dr, Cary, NC 27513.

Keywords

Exercise; Intervention studies; People with disabilities; Randomized controlled trial; Rehabilitation; Wheelchairs

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