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ORIGINAL RESEARCH

Promoting Physical Activity Through a Manual Wheelchair Propulsion Intervention in Persons With Multiple Sclerosis

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Abstract

Objective: To examine the efficacy and feasibility of a multifactorial intervention to increase lifestyle physical activity in nonambulatory persons with multiple sclerosis (MS) based on wheelchair optimization, propulsion skill/technique training, and behavioral strategies based on social cognitive theory.

Design: Randomized controlled trial, 3-month postintervention follow-up.

Setting: Home and general community, and university research laboratory.

Participants: Nonambulatory individuals with MS (N = 14; mean age ± SD, 53.6±8.7y) were randomly assigned to an intervention group (IG) or a control group (CG).

Interventions: After baseline testing, the IG participants received custom-fit, ultralightweight manual wheelchairs with propulsion/skills training, followed by 3 months of at-home use with the custom ultralightweight wheelchair and weekly phone calls to deliver support through a multifactorial intervention. The CG participants received no training and used their own wheelchairs at home during this time.

Main Outcome Measures: All subjects were assessed at baseline and 3 months later for fatigue (Fatigue Severity Scale), upper extremity strength (digital handheld dynamometer), and propulsion technique (on a treadmill [0.5m/s] with instrumented wheels). Two 1-week bouts of physical activity were measured in both groups from home with wrist-worn accelerometry at the beginning (IG and CG in own wheelchairs) and end (IG in study wheelchair, CG in own) of the 3-month period of home use.

Results: The intervention was well tolerated, and no adverse events were reported. The IG demonstrated increased strength ($P = .008$) and a trend toward less fatigue ($P = .068$), both with large effect sizes ($d > 0.8$), as well as reduced application of braking torque during propulsion ($P = .003$) with a moderate/large effect size ($d = .73$), compared with the CG.

Conclusions: Findings suggest a 3-month physical activity intervention based on manual wheelchair propulsion and training is safe and feasible for some wheelchair users living with MS and may produce secondary benefits in strength, fatigue, and propulsion technique.

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There is increasing evidence regarding the importance of physical activity (PA) among persons with multiple sclerosis (MS).[1] PA is defined as bodily movement produced by contraction of skeletal muscles that results in increased energy expenditure,[2] and can be accumulated as part of one's everyday life.[3] This lifestyle PA can be measured objectively using body-worn accelerometers,[4] and has been associated with subclinical and self-reported cardiovascular health,[5,6] walking mobility,[7] information processing speed,[8] symptoms of fatigue,[9] depression, pain,[10,11] and quality of life[12] in MS. PA further can be transformed through multifactorial interventions that provide participants with the necessary resources, skills, and strategies for successful health behavior change. To date, such interventions have been delivered using the Internet,[10] telephone,[13] and pamphlets,[14] and successfully increased PA with secondary benefits for symptoms. However, these interventions have only been delivered among ambulatory persons with MS, and little is known regarding their feasibility, safety, and efficacy when used for increased PA among mobility device users with severe MS.[3]

Despite the documented benefits of PA, many persons living with MS are physically inactive and sedentary, and this is

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particularly salient among nonambulatory individuals. For example, both worsening symptoms and increased levels of disability have been associated with reduced PA.[15,16] Additionally, those using mobility devices often find unique challenges to accessing safe and effective methods of exercise.

Consequently we wondered whether delivering a multifactorial intervention based on manual wheelchair propulsion (MWP) for nonambulatory persons with MS could be successful if the proper technology and training were provided. MWP was selected over formal exercise training to determine the extent to which it affords individuals the flexibility to choose the time, duration, and environment in which activity occurs, along with offering those who experience fatigue the convenience of combining exercise and community participation.

This randomized, controlled pilot study examined the efficacy and feasibility of the intervention among nonambulatory persons with MS. We hypothesized that the intervention group (IG) would tolerate MWP with few adverse events and increase PA levels based on wrist accelerometer vector counts. We further hypothesized secondary benefits in propulsion technique, upper limb strength, and fatigue in the IG compared with a control group (CG).

Methods

Participants

Participants were recruited through the North American Research Committee on MS, phone calls to previous research participants, and local MS Society events. Twenty participants were then screened over the telephone for the following inclusion criteria: (1) diagnosis of MS (later confirmed by participants' physicians); (2) full-time wheelchair user (use of power or manual for >40h/wk and >80% ambulation); (3) aged 18 to 64 years; (4) stable health status for the past 3 months; and (5) bilateral gross upper extremity strength of at least 4-/5 (acquired later at University of Illinois at Urbana-Champaign labs). Exclusion criteria were as follows: (1) wheelchair athletes; (2) orthopedic upper extremity impairment; (3) self-reported history of cardiovascular or cardiopulmonary disease; and (4) pressure ulcers. Of those initial 20 interested participants, 6 were excluded (3 did not use a wheelchair full time, and 3 were unable to travel).

Study design/procedures

Overview

The local institutional review board approved all experimentation. Participants were randomly assigned to either an IG or a CG on a 2:1 ratio to best characterize the IG, but still have data on test stability and administration from the CG (fig 1). Participants (IG and CG) visited the university labs 2 times, for baseline (visit 1) and posttesting (visit 2) (fig 2).

List of abbreviations:

CG	**control group**
FSS	**Fatigue Severity Scale**
IG	**intervention group**
MS	**multiple sclerosis**
MWP	**manual wheelchair propulsion**
PA	**physical activity**
RESNA	**Rehabilitation Engineering Society of North America**

Intervention group

During visit 1, IG participants were examined for upper limb strength and fatigue. Next they received seating evaluations to configure the study wheelchair (ICON A1 wheelchair[a]) to meet their needs. Next, baseline propulsion biomechanics were recorded followed by technique/safety training. The IG participants were then given the ICON for 3 months of home use and encouraged to incorporate it into their daily lives. Example activities were provided to help them achieve this endeavor. During home use, wrist-worn accelerometers were sent through the mail to record two 1-week bouts of PA at the beginning and end of the 3-month period (see fig 2). Bout 1 consisted of activity using their primary mobility device(s) (not the ICON), while bout 2 recorded activity with the ICON. Finally, IG participants returned to the lab 3 months after visit 1 for follow-up testing identical to baseline.

Study wheelchair

The ICON A1 wheelchair is a rigid, ultralightweight, aluminum-framed manual wheelchair meeting Rehabilitation Engineering Society of North America (RESNA)/American National Standards Institute voluntary standards. This chair was selected because it offered the flexibility to meet the standards set forth by RESNA in a position paper[17] on the application of ultralight manual wheelchairs. These standards include durability, adjustability, customization, and the ability to meet the specific mobility and postural needs of the intended user. The ICON is fully adjustable (eg, width, length, footrest height, seat/back angle, center of gravity, back height) and weighs <25lb with rear suspension (fig 3A and B). All ICON wheelchairs had 25-in quick release rear wheels with pneumatic tires and 4-in-diameter front caster wheels. An external contoured aluminum back support[b] was attached for added postural support, and Varilite seat cushions[c] were provided.

Training

Safety and technique training were provided to IG participants by an occupational therapist and a licensed physical therapist with an Assistive Technology Professional certification. An instructional multimedia presentation used previously was presented as well.[18] The multimedia presentation guidelines are consistent with the recommendations published by the Consortium for Spinal Cord Medicine to prevent upper limb pain and injury.[19] Manual wheelchair users are encouraged to use low-frequency, long and smooth strokes (large contact angle) during the propulsive phase to decrease the force exerted at a given velocity.[19] Additionally, subjects are encouraged to match the speed of the handrim on contact to minimize braking torques that slow the wheel.

Behavioral intervention

Based on social cognitive theory,[20] the behavioral intervention was delivered through weekly phone calls by a physical therapist to IG participants, during which strategies for initiation and maintaining PA with the ICON were taught. Such strategies included self-monitoring, goal setting, planning, optimizing outcome expectations, enhancing self-efficacy, overcoming barriers, and identifying facilitators.

Wheelchair data logger manipulation check

Only the IG members' ICON wheelchairs were equipped with data loggers to ascertain the 3 months of home use. Additionally, the data logger allowed researchers to determine whether wrist accelerometer vector counts accumulated during the second 1-week period of home use resulted from ICON use or their own