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BRIEF REPORT

Independent, Community-Based Aerobic Exercise Training for People With Moderate-to-Severe Traumatic Brain Injury

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Abstract

Objective: To determine whether people with moderate-to-severe traumatic brain injury (TBI) can adhere to a minimally supervised, community-based, vigorous aerobic exercise program.

Design: Prospective trial.

Setting: Young Men's Christian Association (YMCA) facilities.

Participants: Community-dwelling volunteers (N=10; 8 men, 2 women; age range, 22–49y) 6 to 15 months after moderate-to-severe TBI.

Intervention: Participants received memberships to local YMCAs and brief orientations to exercise. They were then asked to independently complete ≥12 weeks of ≥3 training sessions per week, performed at 65% to 85% of maximum heart rate for ≥30 minutes per session. Participants could self-select exercise modality, provided they met intensity and duration targets. Programmable heart rate monitors captured session intensity and duration.

Main Outcome Measures: Independence with equipment and facility use and compliance with training goals (session frequency, duration, intensity, total weeks of training).

Results: All participants achieved independence with equipment and facility use. All met at least 2 of 4 training goals; half met all 4 goals. Participants averaged (±SD) 3.3±0.7 sessions per week for 13 weeks (range, 6–24). Average ± SD session duration was 62±23 minutes, of which 51±22 minutes occurred at or above individuals' heart rate training targets.

Conclusions: People in recovery from moderate-to-severe TBI can, with minimal guidance, perform vigorous, community-based exercise. This suggests that decentralized exercise may be logistically and economically sustainable after TBI, expanding its potential therapeutic utility and rendering longer-duration exercise studies more feasible.

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Habitual aerobic exercise improves cardiovascular endurance and positively affects mood and functional capacity. Increasing evidence suggests it also influences cognition in many populations, including people with stroke,[1,2] brain injury,[3,4] and Alzheimer disease[5,6] as well as those at increased risk of dementia.[7,8] Since impairments in cognition, endurance, functional capacity, and mood are all sources of morbidity after traumatic brain injury (TBI), aerobic exercise may represent a valuable nonpharmacologic adjunct. Improvements in cardiovascular endurance are demonstrable after 12-week aerobic exercise programs in most populations,[9] while mood and cognition changes can take >6 months to manifest.[5,6] TBI survivors can safely perform vigorous exercise[10] and comply with short, supervised group training.[3,4,10] However, they frequently have limited transportation access, which restricts participation in longer exercise programs requiring multiple

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weekly visits to distant training sites. Decentralized, independent exercise may offer an alternative, if reliable participation can be ensured.

The goals of this study were to determine whether community-dwelling people with moderate-to-severe TBI could demonstrate the physical, cognitive, and behavioral skills necessary to adhere to an independent, community-based cardiovascular exercise program, and whether they could maintain an intensity, duration, and frequency known to improve cardiovascular endurance.

Methods

Screening

After obtaining approval by the Committee for Clinical Investigation at Beth Israel Deaconess Medical Center and Braintree Rehabilitation Hospital, a query of Braintree Hospital's admission database identified patients aged 18 to 50 years with moderate-to-severe TBI during an 18-month period. Chart review identified those who met study criteria. Inclusion criteria were as follows: (1) English speaking; (2) visual acuity adequate for safe participation; (3) resident of a community served by a participating eastern Massachusetts Young Men's Christian Association (YMCA); and (4) competent to give informed consent. Exclusion criteria were as follows: (1) premorbid or injury-related musculoskeletal or neurologic impairment that would render cardiovascular exercise dangerous; and (2) premorbid or injury-related medical disorders for which rigorous cardiovascular exercise is contraindicated (deep venous thrombosis, active coronary artery disease, valvular heart disease, peripheral vascular disease, obstructive lung disease, uncontrolled hypertension, uncontrolled diabetes). Figure 1 summarizes screening and enrollment.

Enrollment

Ten patients replied to telephone contact and completed in-person evaluations on a rolling, first-come basis, including a history and physical examination with a study physician. Where possible barriers to participation arose, participants furnished current medical records to confirm they could safely participate. Brain injury clinical diagnoses and injury severity were extracted directly from hospital notes. Neuropsychological screening showed residual memory and executive function impairments, but confirmed cognitive recovery sufficient to safely comply with preintervention exercise testing instructions.

Preintervention cardiovascular testing

Participants underwent maximal effort cardiovascular testing (modified Bruce protocol with continuous 12-lead electrocardiogram and blood pressure monitoring, using a treadmill or bicycle) to confirm cardiovascular safety for exercise. Observed maximum heart rates were used to calculate individual aerobic training zones (65%−85% of maximum). Two participants withdrew from the study before intervention: participant 2 withdrew because of a new diagnosis of deep venous thrombosis diagnosis, and participant 10 withdrew when her nearest YMCA left the study.

List of abbreviations:

HRM heart rate monitor
TBI traumatic brain injury
YMCA Young Men's Christian Association

Intervention

Participants received complimentary individual memberships at local YMCAs for the duration of the study, where they had access to exercise equipment during normal hours. Each was asked to complete ≥12 weeks of exercise, maintaining ≥3 exercise sessions per week of ≥30 minutes per session, and to keep heart rates between 65% to 85% of their observed maximum. Participants received individually programmed, recordable heart rate monitors[a] (HRMs) that continuously displayed heart rate, personal training zone, and session duration, and they wore monitors for all exercise. Initial sessions were supervised by study staff until participants showed they could (1) exercise for ≥30 minutes at target intensity; (2) navigate the gym milieu (negotiate external facilities and entry, find and use locker room/restroom, find cardiovascular exercise area within facility, comply with facility rules); (3) safely operate at least 2 pieces of stationary exercise equipment; and (4) independently operate the HRM. After demonstrating these skills, participants were permitted to exercise independently. Participants were given no additional support beyond what general YMCA members receive. The YMCA staff was informed that participants were involved in an exercise study, given the principal investigator's contact information, and told to share any concerns if or when they arose. Participants were encouraged to exercise outdoors when safe opportunities existed, but received no additional financial support for this. In the event of technical or operational error with the HRMs, participants also kept training logs. Study staff met participants every 3 weeks at their YMCA to download HRM data and review training logs. HRM training intensity parameters were increased incrementally to ensure continued cardiovascular challenge. Participants unable to perform exercise for medical reasons (illness, injury, surgery) during a given study week were permitted to make up sessions at the end of the 12-week period. Downloaded HRM data were analyzed separately to obtain total minutes of exercise and volume of time spent by each participant within his or her target zone.

Results

Table 1 summarizes participant demographics and exercise performances.

Compliance

All participants achieved independence with the use of YMCA facilities, demonstrated proficiency with the programmable HRMs, and could safely and independently use 2 pieces of stationary exercise equipment within 4 training sessions or less. One participant was unable to write in a training log but used an HRM for all training sessions.