Improvements in Walking Speed Experienced by Elders Participating in a Cardiovascular Exercise Program

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ABSTRACT

Purpose: The purpose of this retrospective investigation was to determine: (1) whether a cardiovascular exercise program was capable of improving treadmill gait speed of elderly individuals, and (2) if such an improvement was associated with specific determinants. **Methods:** Twenty residents of a retirement community were assessed at baseline and followed-up after approximately 1 year (mean=10.7 ± 1.1 months) of participation in a prescribed cardiovascular exercise program. On each individual's initial visit, self-regulated walking time for one-quarter mile on a Star Trac 4500 motorized treadmill with no incline was recorded. Individuals were then placed on a cardiovascular exercise program that emphasized walking, which they performed 3 to 5 sessions/week for 20 to 30 minutes/session. At follow-up, individuals repeated the one quarter-mile treadmill walk, and times were compared to those obtained on the initial visit. **Results:** Mean walking treadmill times decreased significantly ($p < 0.05$) from 7.7 ± 2.7 minutes to 5.7 ± 2.1 minutes, with both male and female participants showing similar changes. Baseline walk time and change in walk time at follow-up were highly correlated ($r = .682/p < .0001$), but participants with slower baseline walk times showed the greatest gains. Participant age was also correlated to change in walk time ($r = .389/p = .045$). **Conclusion:** All program participants showed some degree of improvement in walking speed, suggesting that benefits may be applicable to a wide range of elderly groups. However, individuals with the slowest baseline walk times demonstrated the greatest improvement.

Key Words: exercise, activity, walking speed

INTRODUCTION

Recent federally sponsored health reports have strongly recommended exercise for older individuals as a means of delaying and/or preventing physical and psychological disorders associated with aging. Healthy People 2010 and reports by the U.S. Surgeon General have both recognized that significant health benefits among older individuals may be obtained by regularly performed physical activity.[1-3] To achieve maximum benefits, the Centers for Disease Control and Prevention and the American College of Sports Medicine have recommended a minimum of 30 minutes of physical activity of at least a moderate intensity level on most, if not all, days of the week.[4] Such activity enhances healthy aging and helps older individuals to maintain their physical function and independence. In some cases, benefits may be achieved in individuals who are symptomatic for certain diseases, so that loss of function, recurrence of symptoms, and the eventual onset of disability may be delayed, if not prevented.[5-7]

Other important points advanced by the U.S. Surgeon General and by Healthy People 2010 are that significant health benefits may be obtained by regularly engaging in a walking program at moderate intensity. Additional studies have supported these recommendations, and have demonstrated noteworthy findings. For example, Asikainen et al found improvements in aerobic fitness (as determined by VO_{2max}) and body fat composition when postmenopausal females were placed on a regular (3 times per week) walking program.[8] Seki also reported benefits associated with walking, and noted that elderly individuals who walked continuously ≥ 1.0 hour/day had significantly lowered mortality risks from all causes.[9] In addition, Parise et al, reported that brisk walking, with an energy expenditure of approximately 4.5 metabolic units (1 metabolic unit=O_2 consumption of 3.5 ml/min kg^{-1}) is one of the easiest forms of exercise that can be used to meet the American College of Sports Medicine recommendation.[10]

Walking programs have been used to prevent functional decline in older individuals who may encounter restricted activity during hospitalization.[11] Furthermore, walking has been noted to have a positive impact on other conditions that often affect elderly individuals (dementia for example), and has been shown to improve cognitive function.[12,13] Such activity, when performed at the maximum comfortable walking speed, has been suggested as a way to improve walking efficiency among individuals of different ages and varying health status.[14] Other researchers have also sought to identify determinants of gait speed. Among these studies, age has been shown to be a consistent factor, but balance and other factors have been identified as well.[15,16]

Loss of walking speed and efficiency may occur for other reasons, with Clancy et al recently showing diminished lateral

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gastrocnemius electromyographic firing patterns to be associated with slowed walking speed.[17] Aging, however, appears to be the primary factor in loss of walking speed and efficiency, along with associated decreased balance, neuropathy, visual loss, reduced muscle strength, and decreased range of motion among the different joints of the lower extremity.[18-22]

Additional work for clarifying walking speed and efficiency in elderly individuals was done by Steffen et al[23] and Lusardi et al.[24] These investigators examined several clinical tests of mobility, including walking at both comfortable and 'fast' intensities. Their purpose was to provide age-related data for these parameters in a sample of community-dwelling and frail older adults that would serve as a reference for patient comparisons. In addition and more specific to our study, other studies of walking speed and associated physiologic measures have used protocols employing time versus distance measures from subjects ambulating on a motorized treadmill.[25-27] This modality (ie, treadmill) has garnered recent interest for use among investigators largely due to its static nature, thus allowing assessments to be done on participants using equipment that could not easily be advanced alongside an individual as he/she walks on a track or other surface.

We undertook our research to expand the literature base on exercise and its benefits for the elderly. Therefore, with these outcomes in mind, the purpose of this retrospective investigation was to indicate: (1) if a cardiovascular exercise program was capable of improving the treadmill gait speed of elderly individuals, and (2) whether such an improvement was associated with specific determinants.

METHODS

Study Design and Participants

To develop more insight into walking programs and their efficacy for improving walking speed, we carried out a retrospective investigation in which data were collected from individuals who had participated in an ongoing physical therapy program of moderate intensity that emphasized walking as the primary exercise modality. Each person was cleared by a physician before entering the program; all were placed on a protocol that recommended their coming to the Bishop Gadsden Wellness Center (BGWC) in Charleston, South Carolina 3 to 5 times per week to carry out their prescribed ambulation centered activities. Progress in walking speed was then documented retrospectively by comparing treadmill walking speed approximately 1 year (mean = 10.7 ± 1.7 months) after entering the program with treadmill walking speed upon first entering the program. The study was approved by the Medical University of South Carolina Institutional Review Board (IRB). All individuals signed an informed consent statement before participating in the exercise program.

Screening and Selection

The participants were residents of a local retirement community that houses approximately 250 residents. All were involved in an ongoing elderly adult wellness program that was overseen by physical therapists. The participants were generally novice exercisers (although 2 individuals indicated that they had been previously exercising), and ranged in age from 68 to 92 years (mean 79.5±6.8 years).

Individuals expressing interest in taking part in a supervised exercise program at BGWC were further evaluated by a physical therapist for ability to engage in exercise before being allowed to actively take part. Specifically included in the assessment was a history for exploring the presence of active disease and an appraisal of joint range of motion and muscle strength. Potential participants were also asked to identify current prescription medications, including drugs in the beta-blocker class. Individuals who presented with exclusion criteria (emphysema or other significant active respiratory disease), arthritis, and heart disease (cardiomyopathy, angina pectoris, or previous myocardial infarction) were not allowed to take part in the program. All individuals not excluded were informed that they would attend a structured, supervised, and ongoing cardiovascular exercise program, and that their progress would be evaluated on at least an annual basis. Since referrals to the program were received at various times, participants began the program on different dates and were followed over the ensuing 8 to 12 months before being assessed again. Overall, 29 individuals began the program, which represented an acceptance rate of approximately 80% of those who were screened.

Participants were advised before coming to the sessions that they would be exercising, and were instructed to wear light clothing or a sweat suit and sneakers. Each person was told that he/she should attend the exercise sessions 3 to 5 times per week, and that he/she could stop and rest at any time during the sessions as needed. All data and information compiled for this report were collected retrospectively, and anonymity was kept secure during data analysis by assigning each individual an identification number that was recorded on his/her data collection sheet.

Attrition

Of the 29 participants who entered the program initially, 9 individuals who were instructed in the cardiovascular exercise program either never performed the activities or quit the program within 1 month after starting, and are identified as *non-exercisers*. No information was available from the participants' chart records to indicate specific reasons for their lack of willingness to participate in and/or continue in the exercise program. The investigators attempted to retest all the individuals in the non-exercisers group at 10 to 12 months after each person's initial assessment. Of the 9 individuals in this group, only 2 agreed to retest.

Twenty individuals (age = 79.5 ± 6.8 yr), who were instructed in the cardiovascular exercise program, performed the program 3 to 5 times per week for an average of 10.7 ± 1.1 months, and are thus identified as *exercisers*. No adverse events were cited for either group during the time span covered in the present report. In all cases, withdrawal from the study by participants was voluntary, and none were asked to withdraw.

While the comparability of exercisers and non-exercisers cannot be assured, no unusual characteristics were reported in this regard among the non-exercising group.

Procedures

Exercise sessions

Exercisers went to BGWC for all sessions, and attended the exercise sessions 3 to 5 times per week. Exercise sessions generally lasted 20 to 30 minutes each, and were supervised by at least one physical therapist. Generally speaking, the level of exercise intensity required of the participants was estimated to lie within the range of ≥ 4 to ≤ 6 METs, thus placing the activities performed in the light to moderate range of exertion.[28] Approximately two-thirds of the exercisers participated in at least 3 sessions per week. The BGWC was open Mondays through Fridays each week, and participants arranged their sessions at various times of the day via appointment. No other sessions were offered to the participants, and all were asked to refrain from exercising on their own or within other programs.

Participants were advised to begin each exercise session with a warm-up routine of stretching and flexibility exercises. The warm-up routine was then followed by approximately 20 to 30 minutes of cardiovascular exercise, with participants choosing from 1 or more of the following modalities: motorized treadmill, walking on an indoor track, walking outdoors, riding a stationary bicycle, and/or riding a NuStep recumbent cross trainer. Individuals who employed more than 1 modality in a session were encouraged to switch from 1 to the other in circuit training fashion, in which an exerciser moves rapidly between activities sequentially. Before beginning the exercise program, the amount of activity needed to achieve a moderate level of exercise intensity for each individual was estimated. Estimations were done by calculating each individual's target heart rate (ie, the heart rate to reach during an exercise session). This measure has been noted to be a valid assessment of exercise intensity, and was computed as a fraction of heart rate reserve using the following formula: {[(220-age)-resting heart rate]x .0.6} + resting heart rate.[29] Participants were informed as to their estimated target heart rate, were taught how to monitor their radial pulse, and were asked to maintain target heart rates at ± 5 beats per minute. Lastly, participants were advised to end each session with a cool-down period, which consisted primarily of stretching and relaxation. Instructions for proper stretching as well as verbal cues for relaxation were given by the supervising physical therapist.

Pre-test/post-test measures

All participants were given a pretest to estimate baseline-walking speed (T1) on a level surface. To perform the measurements, each individual was given a 2-minute warm-up period, which consisted of walking at a comfortable speed on a Star Trac 4500 motorized treadmill at 0° elevation. Following the warm-up period, each individual was asked to walk 0.25 mile on the same treadmill, again at 0° elevation. Participants were allowed to self-select walking speeds, but were asked to walk as fast as possible without experiencing discomfort. All were allowed to: (1) increase or decrease walking speed throughout the test as desired, and/or; (2) stop the treadmill and stop walking at any point if they felt the need.

Following 8 to 12 months (average 10.7±1.1 months) of active participation in the cardiovascular exercise program, a post-test measure to estimate ending walk speed (T2) was performed on each individual of the exercise group. As in T1, each individual in the exercise group was permitted a 2-minute warm-up that consisted of walking at a comfortable speed on a Star Trac 4500 motorized treadmill at 0° elevation. Following the warm-up period, participants were asked again to walk 0.25 mile on the same treadmill, still at 0° elevation. As was done for T1, they were allowed to self-select walking speed and to walk as fast as possible without experiencing discomfort. Each was advised that he/she could: (1) increase or decrease walking speed throughout the test as desired, and/or (2) stop the treadmill and stop walking at any point if needed. As in T1, we documented the time that each participant took to reach 0.25 mile.

Statistical Analysis

Several different statistical analyses were conducted to determine significant differences and correlations among measurements obtained from the 20 persons comprising the exercisers group. All analyses of data were performed using the SPSS software program.

A paired student's t-test was used to determine whether significant differences existed between the means of T1 and T2. Pearson's correlation (r) was also conducted to describe the relationship between T1-T2 and T1, participants' age, and gender. Finally, multiple regression analysis was conducted to determine to what degree T1, age, and gender were predictors of T1-T2, and to confirm our impressions that baseline walk-time was a better predictor than participant age for improvements over the course of the training program.

RESULTS

Overall mean treadmill walk times for 0.25 mile decreased from 7.7 ± 2.7 minutes to 5.7 ± 2.1 minutes (Table 1). Comparison of the means—ie, baseline (T1) and ending walk time (T2)-via a paired Student's t-test demonstrated statistical significance ($p < 0.05$), although sample size was small.

Change in walk time (T1-T2) was strongly correlated with T1 ($r = -.682/p < .0001$), with participants having slower baseline walk times showing the greatest gains. Participant age was also correlated with T1-T2 ($r = .389/p = .045$). Thus, older participants generally had slower baseline walk times and made noteworthy gains, since slower baseline walk times were consistently and significantly correlated with improvements in walking speed over the course of the program. Lastly, participant gender failed to show a significant correlation with T1-T2 ($r = .125/p = .286$).

Two individuals, 1 female and 1 male reported that they had been engaging in 30 minutes of moderate aerobic exer-

Table 1. Descriptive statistics as related to walking time.

Walking Time	Mean±SD	Min-Max
T1 (minutes)	7.7±2.7	3.9 - 14.3
T2 (minutes)	5.7±2.1	3.7 - 12.4
T1-T2 (minutes)	(2.0)±1.3	-0.1 to -4.7
T1-T2 percentage change	(23.9)±14.1	-1.4 to -45.9

cise approximately 3 times per week prior to entering the BGWC program. While they began the program with the fastest baseline walk times (3.9 minutes and 4.3 minutes), these 2 individuals experienced the smallest gains (-0.2 minutes and -0.1 minutes decreased walk time for 0.25 mile on the treadmill) of any of the participants.

Finally, multiple regression analysis of T1, age, and gender as predictors of T1-T2 revealed that T1 significantly predicted T1-T2 ($p = .009$), whereas neither age ($p = .473$) nor gender ($p = .426$) added to the prediction of this variable. T1 was negatively correlated with change in walking speed and thus demonstrated an inverse association, so that the slower the walking speed at baseline (T1), the greater the change in walking speed at the end of the intervention (T2).

DISCUSSION

This study demonstrates the importance of cardiovascular exercise as a way of improving treadmill gait speed of elderly individuals. When mean values for T1 were compared to those of T2, a significant decrease in walk time was noted, with ranges from -0.2 to -3.3 minutes for females, and -0.1 to -4.7 minutes for males. The investigators felt that an important point of the study was the statistically supported finding that improvements in walk time in the exercisers were more robustly related to baseline walk time than to participant age. For example, the second oldest male participant (89 years) experienced the second greatest decline in walk time (-3.3 minutes for T1-T2) among male participants over the course of the program. By contrast, the oldest female participant (90 years) experienced the third smallest decline in walk time (-1.5 minutes for T1-T2) among female participants, and suggests that exercise programs can produce benefits that may or may not directly relate to an individual's age.

The investigators noted 2 individuals (1 male and 1 female) who reported participating in aerobic exercise that began before the present program, and had done so approximately 3 times per week. Unfortunately, no records were available to obtain an exact length of time or other details for such 'pre-program' aerobic activity. Not surprisingly, each of these participants demonstrated the fastest baseline (T1) walking speed of any of the participants, and showed the least amount of improvement when evaluated at T2. These 2 individuals had most likely achieved an efficient, comfortable walking speed before entering our program, and thus did not gain further significant benefits. However, the investigators note that increases in walking speed were still accrued despite higher fitness levels upon program entry, thus supporting the assumption that increased exercise and improved walk times have a positive linear relationship.

The investigators felt that perhaps one of the most remarkable occurrences of the program was the consistency of attendance at exercise sessions by the participants in the exercising group. Even among the most senior individuals (those ≥ age 85), attendance at the program sessions was very regular, and all the participants demonstrated only incidental absences. Overall, approximately two-thirds of the exercisers came to at least 3 sessions per week in the intervening time between T1 and T2. Furthermore, all participants were able to come to the exercise sessions for a protracted time period, ie, for the time elapsed between T1 and T2, or an average of 10.7 ± 1.1 months. Since the data were gathered from existing records, and were thus retrospective in nature, the investigators were unable to explore attitudes of satisfaction with the program or feelings on the part of the participants concerning their general health and wellness. However, overall verbal and anecdotal reports from the attending physical therapists suggested that participants were very pleased with their efforts, felt that their participation in the program had brought them more energy and endurance for their daily activities, and had improved their quality of life.

CONCLUSION

The results of the present retrospective investigation suggest that an ongoing exercise program produces measurable physical benefits in the form of improved treadmill walking speed, as demonstrated by the performance of well-elderly individuals comprising a mixed gender sample. A limitation to the practical applicability of these findings, however, is that self-selected walking speed on a treadmill may lack equivalence to self-selected walking speed over ground, a comparison that the authors plan to explore in subsequent investigations.

The authors believe that physical therapists should understand the need to encourage elderly individuals to regularly engage in aerobic exercise, and should monitor progress closely to observe changes. We anticipate that our findings will be of interest to all health professionals having an interest in exercise and the elderly, and will further help in defining ways to employ exercise as a therapeutic modality to improve patient outcomes.

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