
Objective: To compare temporal, spatial, and oxygen costs of gait while elderly subjects walked without an assistive device, with a new assistive device, and with 2 other commercially available assistive devices.

Design: Descriptive, repeated measures.

Setting: University-based research laboratory.

Participants: Thirteen healthy older subjects who could walk without an assistive device.

Interventions: Not applicable.

Main Outcome Measures: Gait speed, normalized gait speed, cadence, stride lengths, 5-minute walk distance and gait speed, oxygen consumption (V\(\text{O}_2\)) per meter walked, respiratory exchange ratio (RER) per meter walked, and minute ventilation per meter walked.

Results: Gait speed, normalized gait speed, and stride lengths decreased when the Merry Walker device was used, compared with walking without an assistive device. Outcome measures when walking with either the wheeled walker or the WalkAbout did not differ significantly from walking without a device except for a faster cadence with the WalkAbout. The distance walked and gait speed were decreased and the RER and minute ventilation were increased during the 5-minute walk with the Merry Walker compared with normal walking. The V\(\text{O}_2\) was higher with the wheeled walker and Merry Walker than when walking without an assistive device, but there was no difference when the WalkAbout was used.

Conclusions: Older adults walked in the new assistive device, the WalkAbout, with parameters that did not differ significantly from their gait without a device. The oxygen demands of walking were similar to unassisted walking for the WalkAbout, but were higher for the wheeled walker and Merry Walker. These results may help guide the prescription of assistive devices for older adults.

Key Words: Aging; Assistive devices; Gait; Rehabilitation; Walkers.

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FALLING IS THE PRINCIPAL problem for elderly people who are limited in their ability to walk. Approximately 30% of adults over the age of 65 will fall each year, and the rate rises dramatically with increasing age.1 Thus, every year 50% of people over the age of 80 will fall, and the rate is significantly higher among people who live in nursing homes.2 The incidence of hip fractures resulting from falls is increasing disproportionately faster than in the general population, which reflects the increasing proportion of the population that is elderly. Falls are the reason for 40% of nursing home admissions,3 and fear of falling leads to inactivity and poor quality of life.3 There is little question that injuries from falls are a major health risk for the elderly and that falls have financial and sociologic implications.

Elders who are at risk for falls often used assistive devices. A very common device to assist walking is the standard “walker,” or some variation of it. More than 1.5 million people in the United States use walkers, and many use them for several years; there is little doubt that both standard walkers and wheeled walkers provide greater stability and assistance than a cane. Walkers, however, have numerous limitations. Most importantly, people who use walkers still fall frequently. A recent study4 found that 71.9% of falls occurred in a sideways direction and another 10% were in a backward direction. Thus, most falls occur in the directions that are not protected by a walker. Furthermore, in 16% of the cases walkers or crutches contributed to the falls.5 There are studies that indicate that the use of walkers can potentially interfere with the performance of compensatory stepping6 and grasping during balance recovery.6 Other studies also substantiate that walkers, canes, wheelchairs, or other assistive devices actually contributed to the falls.7 Numerous other problems with walkers are commonly reported. In a recent survey,8 57% of subjects who used walkers categorized the devices as “dangerous and/or difficult to use,” and an additional 17% owned walkers that they no longer used because their physical and/or mental status had declined (reflecting the difficulty in using the walker). Thus, 74% of the 360 subjects in that survey characterized their walking aids as either dangerous, difficult to use, or both. This perception contributed to the fear of falling while using a walker, thereby decreasing the amount of walking by subjects who used walkers. Most users felt that walkers did not sufficiently reduce the likelihood of falling. The requirement for upper-body strength was limiting for some. Importantly, only 2% felt that there is any stigma associated with using a walker,9 indicating that if a good ambulation assistance device were available, it would be well accepted.

A new device, the WalkAbout,4 has been developed to address some of the problems associated with a standard walker.10 The WalkAbout was tested with 65 elders who were unable to walk independently in an acute hospital setting and in a nursing home.10 Ninety-five percent of the patients reported

From the Department of Physical Therapy, University of Texas Medical Branch Galveston, TX (Protas, Tissier); and Innovative Health Solutions, League City, TX (Raines).

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A commercial party having a direct financial interest in the results of the research supporting this article has conferred or will confer a financial benefit upon the author or 1 or more of the authors, Raines is the inventor of the WalkAbout; she did not participate in the data collection or data analysis.

Reprint requests to Elizabeth J. Protas, PhD, PT, Dept of Physical Therapy, University of Texas Medical Branch, Galveston, TX 77555-1028, e-mail: ejprotas@utmb.edu.

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feeling safe in the device. They walked on average 167±33m with the new device in a single bout compared with only 28±5m with their usual assistive device.

There is a need to further characterize walking in the new device in relation to other assistive devices. There are few studies in the literature that have compared assistive devices. Our purpose in this study was to compare gait characteristics and oxygen cost of the new device, other commercially available walking aids, and unassisted walking in healthy, older adults.

**METHODS**

**Participants**

Thirteen healthy, community-dwelling elders between the ages of 70 and 90 years who could walk unassisted agreed to participate in the study (table 1). Subjects were recruited through the subject registry from the University of Texas Medical Branch, Claude D. Pepper Older Americans Independence Center and through advertisements in the local newspaper. An investigator reviewed with each subject his/her medical history to rule out any major acute or chronic health condition that would affect their walking, such as a history of stroke with residual hemiparesis or severe osteoarthritis of the lower extremities. Seven subjects completed both the gait analysis comparisons and the oxygen consumption (\( V\dot{O_2} \)) comparisons. Three subjects completed only the gait analysis and another 3 completed only the \( V\dot{O_2} \) comparisons; therefore, we had 10 subjects in the gait comparisons and 10 subjects in the \( V\dot{O_2} \) comparisons. Technical problems with the portable gas analyzer prevented 6 subjects from completing the \( V\dot{O_2} \) comparisons. Subjects provided written informed consent according to procedures approved by the institutional review board at the University of Texas Medical Branch in Galveston.

**WalkAbout Description**

The user is completely surrounded in a frame when using the WalkAbout (figs 1, 2). One side opens to let a user enter and then close the device securely. The device moves by body contact as the user walks. The WalkAbout is available in 3 sizes, small, medium, and large, to accommodate people of different heights. The top rail is positioned approximately waist high to provide stability. The footprint of the base of the device is larger in circumference than the top rail, so that its legs are attached to the top rail at an outward angle toward the base to provide maximum stability. There are brakes on 2 wheels to provide stability while a user enters, exits, or sits. The WalkAbout is made of 14-gauge carbon steel and is designed to support full body weight. Its caster wheels let it roll easily over the ground. The device moves as the user walks as a result of the attachment of a safety seat to the WalkAbout (see figs 1, 2). Consequently, users do not need upper-body strength to walk and can rest their arms on the top rail, which is padded for comfort.

**Procedures**

**Gait analysis.** We used an instrumented walkway (GAIT-Rite)\(^b\) to measure temporal and spatial parameters of gait. To normalize the spatial parameters to a subject’s height, we measured his/her leg length from the greater trochanter to the lateral malleolus and entered that data into the system, along with the subject’s age, sex, height, and weight. The subject stood at the end of the 3.6-m (12-ft) walkway and then walked at his/her fastest, but safest, speed to the other end of the walkway. This test was repeated twice for each condition and the 2 trials were averaged for definitive data. Subjects performed the test under 4 conditions: fast walking without an assistive device, walking with a WalkAbout, walking with a standard, wheeled walker, and walking with a Merry Walker.\(^c\) We selected the Merry Walker because it is a walker-chair combination that surrounds the user and is somewhat similar in design to the WalkAbout. The frame of the Merry Walker is made of 16-gauge steel that is bottom weighted to avoid tipping. The height of the wheeled walker was adjusted for each subject’s standing position, with the walker approximately 30cm in front of the subject. The walker height was adjusted so that one’s elbows were in approximately 30° of flexion when the walker was being held. The WalkAbout height was adjusted so that the top bar was approximately waist...
high for each subject. The Merry Walker is not adjustable but is available in small (1.45–1.55m [58–62 in]), medium (1.58–1.67m [53–57 in]), and large sizes (1.70–1.80m [68–72 in]). We used the appropriate size for each subject. Each condition was performed in random order to avoid a learning effect.

The primary spatial parameter measured by the GAITRite was stride length measured on the line of progression between the heel points of 2 consecutive footfalls of the same foot (fig 3).

The temporal parameters of gait measured were: (1) gait speed obtained after dividing the distance (measured on the horizontal axis from the heel point of the first footfall to the heel point of the last footfall) by the ambulation time (time elapsed between the first contacts of the first and the last footfalls), expressed in meters per second; (2) cadence, expressed as the number of steps per ambulation time (in steps/min); and (3) normalized mean gait speed, expressed as gait velocity divided by leg length (LL) (in m/s by LL/s).

We used stride length, gait speed, cadence, and normalized gait speed as our outcome variables for both unassisted gait and gait with the 3 assistive devices. The GAITRite has been reported to be valid and reliable in repeated testing with healthy subjects\textsuperscript{11,12} and subjects using an assisted gait.\textsuperscript{13}

Subjects were fitted with a portable gas analyzer (VO\textsubscript{2000})\textsuperscript{6} that measures oxygen consumed and heart rate during functional activities. The VO\textsubscript{2000} is a lightweight, portable device that has a mouthpiece for collecting expired air, sensors for analyzing oxygen and carbon dioxide content of expired air, a heart rate monitor, a battery pack, and a transmitter worn by the subject. A receiving unit receives and stores the transmitted data. These data are then downloaded into a computer to calculate values for VO\textsubscript{2}, minute ventilation, and respiratory exchange ratio (RER).

Measurements taken with portable gas analyzers are reported to be as valid as those taken with a standard metabolic cart, with a Pearson product-moment correlation of .90,\textsuperscript{13} and to demonstrate test-retest reliability during submaximal and maximal workloads with intraclass correlation coefficients ranging from .78 to .86.\textsuperscript{14} We tested the test-retest reliability of a portable gas analyzer on 40 healthy subjects in our lab while the subjects walked back and forth over a 5-m walkway. The device was reliable with a coefficient of .83. Although walking on ground over a short distance with frequent turns is slightly different than walking on a rectangular path, as in this procedure, it does demonstrate that the protocol is reliable. We selected a portable device rather than a standard metabolic cart to give the subject greater freedom of movement when using the assistive devices.

The subjects’ age, sex, height, and weight were entered into the system. The VO\textsubscript{2000} was calibrated according to the manufacturer’s directions with gases of known content and volume.

Fig 2. Subject seated in the WalkAbout. Reprinted with permission of the American Congress of Rehabilitation Medicine and American Academy of Physical Medicine and Rehabilitation.\textsuperscript{19}

Fig 3. Spatial parameters of gait. Reprinted with permission of CIR Systems Inc.
before each subject was tested. A heart rate monitor was placed around the thorax. A mouthpiece was placed in the subject’s mouth to collect expired air, and a clip was placed on the nose to eliminate any breathing through the nose. The analyzer was placed in a small backpack worn by the subjects, who stood for several minutes to become familiar with breathing with the device before the test was started.

Subjects walked for 5 minutes (the 5-minute walk test [5MWT]) and were allowed to rest until they indicated they were ready to begin the next test. The rests generally lasted from 3 to 5 minutes. The mouthpiece and nose clip were removed between tests. All tests were conducted on the same day. The data were downloaded to the computer in order to calculate the V\text{\textsubscript{\text{\textcircled{O}}}}\text{\textsubscript{2}} per millimeter per body weight per minute (in mL·kg\textsuperscript{-1}·min\textsuperscript{-1}). Samples were taken every 20 seconds and averaged to obtain the oxygen consumed in each minute. The values obtained during minutes 4 and 5 of the task were the definitive data and were averaged. This ensured that a meta-definitive data and were averaged. This ensured that a meta-

### Data Analysis

We calculated group means and standard deviations (SDs) for each of the walking conditions. We used analysis of variance (ANOVA) with repeated measures to compare group means. Alpha was set at .05. Post hoc follow-up tests were completed when a significant F value resulted to determine where the differences occurred. The post hoc tests consisted of paired sample t tests between the normal condition and each of the 3 assistive devices. We used a Bonferroni adjustment on the \(\alpha\) to account for multiple comparisons (.05/4 = .0125).

### RESULTS

Ten subjects aged 65 years and older were tested for the spatial and temporal parameters of gait, and 10 subjects were tested with the portable oxygen analyzer while walking (see Table 1). Seven subjects did both the gait and the 5MWTs. Three subjects completed the gait tests only and another 3 completed the 5MWT.

Table 2 shows the means and SDs for the gait tests. The results of the repeated-measures ANOVA for the gait parameters indicate there were significant differences between conditions for each of the dependent variables. Follow-up comparisons yielded significant differences when unassisted walking was compared with the Merry Walker for stride length (\(t_{6}=7.04, P<.001\)), speed (\(t_{6}=3.53, P<.006\)), and normalized gait speed (\(t_{6}=3.62, P<.006\)), and when unassisted walking was compared with the WalkAbout for cadence (\(t_{6}=2.97, P<.016\)).

Table 3 shows the means and SDs for the 5MWT. The results of the repeated-measures ANOVA for the 5-minute walk variables indicate there were significant differences between conditions for each of the dependent variables. Follow-up comparisons between the Merry Walker and unassisted walking yielded significantly lower values for distance walked (\(t_{6}=-4.49, P<.002\)) and gait speed (\(t_{6}=-3.93, P<.003\)), and higher values for RER (\(t_{6}=-3.63, P<.005\)) and minute ventilation (\(t_{6}=-4.07, P<.003\)) when using the Merry Walker. V\text{\textsubscript{\text{\textcircled{O}}}}\text{\textsubscript{2}} was higher when subjects used a wheeled walker and the Merry Walker, compared with unassisted walking.

### DISCUSSION

The spatial and temporal characteristics of elderly subjects while using the WalkAbout are comparable to unassisted, fastest walking except for faster cadence. The wheeled walker also had comparable gait values compared with unassisted gait. With the Merry Walker, subjects consistently had reduced gait speed and normalized gait speed and decreased stride lengths compared with unassisted walking or when walking with the other assistive devices. A recent comparison\textsuperscript{15} of gait when using a wheeled walker and unassisted gait in young adults performing a partial weight-bearing gait demonstrated significantly lower gait speed, cadence and step, and stride lengths with the wheeled walker. These results were accompanied by reduced vertical peak ground reaction forces for both the partial weight-bearing lower extremity and the other lower extremity, indicating that the additional force was placed on the upper extremities while walking with the wheeled walker. Our elderly subjects were encouraged to walk as normally as possible at their fastest pace while using the devices and they were able to accomplish this using the wheeled walker and the Walk-
About. Another study compared results with a standard walker, wheeled walker, and unassisted ambulation in elderly patients with Parkinson’s disease who had motor blocks or freezing while walking. Walking speed was significantly reduced for subjects using either assistive device compared with the unassisted condition. Our subjects, in contrast, did not have any neurologic conditions, and did not have a reduction in walking speed with 2 of the 3 devices. Several subjects noted that the seat of the Merry Walker limited their step lengths while walking, but this did not occur with either the wheeled walker or the WalkAbout.

It should be noted that we instructed our subjects to walk at their fastest, but safest, speed during this short gait test. Consequently, the gait speeds are slightly higher than those reported in a study of subjects in a similar age range. This allowed us to compare walking with and without the devices at a faster speed than the self-selected speed during the 5MWT in our group of healthy, older adults. This may limit the generalizability of these comparisons with clinical situations in which people often walk much slower, because the spatial (stride length) and temporal (cadence) measures we observed are speed dependent. As a follow-up to this study, we tested older people who displayed mobility disabilities and compared their walking with the usual assistive device and the WalkAbout. We found comparable gait speed, step length, and distance walked in 5 minutes when subjects were walking in the WalkAbout or the usual assistive device.

The results of the 5MWT were consistent with what we observed during the shorter walking task. In that distance walked and gait speed were less when the subjects walked with the Merry Walker than when walking unassisted. Although these variables were reduced when the subjects walked with the wheeled walker and the WalkAbout, these differences were not significant. The VO2 values were higher than normal as subjects walked with the wheeled walker and the Merry Walker. Values for the RER and minute ventilation per meter walked were also higher with the Merry Walker. Previous research has reported that VO2 per meter walked while using a wheeled walker and the Merry Walker. Previous research has reported for the RER and minute ventilation per meter walked were also during unassisted ambulation and ambulation with the wheeled walker and the Merry Walker. These subjects were also healthy, older adults who did not have a reduction in walking speed with 2 of the 3 devices. Several subjects noted that the seat of the Merry Walker limited their step lengths while walking, but this did not occur with either the wheeled walker or the WalkAbout.

Differences in our results compared with those of previous research were consistent with the fact that our subjects were bearing weight equally on both lower extremities during walking. These subjects were also healthy, older adults who did not use assistive devices. Higher VO2 with the assistive devices could be attributed to a subject’s lack of habitual use of these devices. The higher oxygen costs for the wheeled walker and the Merry Walker may reflect greater upper-extremity support when using these devices. We did not attempt to control the amount of upper-extremity support during walking with the devices; this was a limitation of our study.

Walkers also present other limitations. A wheeled walker is difficult to use on uneven surfaces such as walking outside on grass. Both the Merry Walker and the WalkAbout share this limitation. In addition, the Merry Walker and WalkAbout have relatively wide bases that limit their utility in confined spaces.

**Study Limitations**

There are several limitations to this study. Our subjects could walk without an assistive device, therefore, they did not represent the population that is in need of such devices. Future studies should investigate the effect on walking with the WalkAbout among mobility-impaired subjects. Also, the number of subjects tested was small, which might influence study results, although, our results appear consistent with previously published work. Finally, our subjects had only a short time to become familiar with each device; however, none reported having difficulty in adapting their walking when using the different devices.

**CONCLUSIONS**

With the new assistive device, the WalkAbout, users demonstrated spatial and temporal parameters of gait that are comparable to walking without an assistive device. Another assistive device comparable to the WalkAbout impeded normal gait. The oxygen demands of walking were similar to those in unassisted walking for the WalkAbout, but were higher for the wheeled walker and the Merry Walker. These results may help when prescribing assistive devices for older adults are prescribed.

**References**


 Suppliers
a. Innovative Health Solutions, 4204 Pebble Beach Dr, League City, TX 77573.
b. CIR Systems, 60 Garlor Dr, Havertown, PA 19083.
c. Merry Walker Corp, 21350 S Sylvan Dr, Mundelein, IL 60060.
d. ML6; Meterman Test Tools, PO Box 9090, Everett, WA 98206.
e. Medical Graphics Corp, 350 Oak Grove Pkwy, St. Paul, MN 55127.