Comparability of the 6-min Walk Test Using Different Test Configurations

Del N. Konopka, Robin P. Shook, Marian L. Kohut, Rosalie Vos Tulp, and Warren D. Franke

The 6-min walk test (6MWT) is a common component of fitness assessments of older adults; however, differing course configurations might affect 6MWT performance. It is unclear how comparable 2 different configurations are. To determine the comparability of 2 courses, 35 adults ≥65 years of age completed two 6MWT, once walking around a 20- by 5-yd outdoor rectangle and once on an indoor oval track (circumference 144.3 yd). Scores for the 2 tests were internally consistent (intraclass correlation coefficient = .95). The participants walked farther on the oval track than around the rectangle (639 ± 19 vs. 582 ± 16 yd; p < .0001), but responses to the rectangular configuration could be readily estimated using the equation 66.7 yd + 0.807 × (oval walking distance), $R^2 = .85$. Thus, within-participant responses are similar across both 6MWT, but the course configuration affects the distance walked.

Keywords: older adults, senior fitness, cardiorespiratory fitness

When evaluating the cardiorespiratory fitness levels of older adults, a commonly used component of such assessments is a walk test. Of the various walk tests available, a recent review concluded that the 6-min walk test (6MWT) was the most extensively researched and was likely the best choice over other walk tests for older adults (Solway, Brooks, Lacasse, & Thomas, 2001). There is not a clear consensus, however, on the best walking-pathway configuration to use. The American Thoracic Society (ATS Committee, 2002) officially recommends walking between two cones placed 33.33 yd apart (2002). Nevertheless, other studies have had participants walk between two cones placed 19.62 yd (Kervio, Carre, & Ville, 2003), 21.8 yd (Gayda, Choquet, Temfemo, & Ahmaidi, 2003), 32.7 yd (Brooks, Solway, Weinacht, Wang, & Thomas, 2003), and 54.5 yd (Troosters, Gosselein, & Decramer, 1999) apart. Others required walking in a 13.33-yd-diameter circle (Harada, Chiu, & Stewart, 1999). The Senior Fitness Test (Rikli & Jones, 2001), a well-validated test battery for older adults with an extensive normative data set, requires walking around a 20- by 5-yd rectangle. Regardless of the configuration used, the 6MWT demonstrates acceptable internal consistency; for example, the
6MWT of the Senior Fitness Test has an intraclass correlation coefficient of .88 (Rikli & Jones, 1998).

The extent to which differences in the configuration of the 6MWT affect performance is unclear. If differences in the configuration do affect performance, comparisons between otherwise similar studies would be difficult. Limited evidence suggests that this might indeed be the case. In a 17-site multicenter study in which the configuration of the 6MWT varied across sites, participants walking without directional change performed ~10% better than participants walking with angular turns between two markers (Sciurba et al., 2003). Although that study assessed primarily older adults, its generalizability is limited. All participants had marked chronic obstructive pulmonary disease (COPD), with some participants requiring supplemental oxygen while exercising. Thus, the extent to which the 6MWT configuration affects performance in relatively healthy older adults remains unknown.

In summary, the 6MWT is in widespread use as a tool to assess cardiorespiratory fitness levels in older adults. There are considerable differences in the configuration of the 6MWT, however, and the comparability of the results from these different arrangements is unclear. Thus, the purpose of the current study was to determine the comparability of two configurations of the 6MWT—walking on a course that requires directional change (e.g., out-and-back or making sharp turns) compared with walking in an oval pattern without a significant directional change. The Senior Fitness Test was chosen to represent the former 6MWT configuration because of its extensive validation (Rikli & Jones, 1998; 1999a; 2001) and normative data set (Rikli & Jones, 1999b; 2001). The configuration endorsed by the American Thoracic Society was not used here primarily because neither reference equations nor extensive normative data sets have been created for relatively healthy older adults. An oval track represented the latter 6MWT configuration, because it provided a consistent surface for all participants, they could be readily monitored throughout the test, and the mild curvature of the track enabled participants to walk with gradual directional change.

Method

Participants

Current participants in a longitudinal exercise-training study were recruited for the current study; 35 participants volunteered. The participants were apparently healthy, had completed a medical assessment by a physician, and had successfully completed a cardiac stress test. All had been engaged in a program of structured exercise for the preceding year, exercising three times weekly with each session lasting 1 hr. Ethical approval was given by the Iowa State University institutional review board, and informed written consent was obtained from the study participants. The participants consisted of 22 women and 13 men all over 65 years (71 ± 1) with an estimated $\text{VO}_{2\text{peak}}$ of $30.1 ± 1.2 \text{ ml \cdot kg}^{-1} \cdot \text{min}^{-1}$ (modified Bruce treadmill protocol, $\text{VO}_{2\text{peak}}$ estimated by time to test termination; Foster et al., 1984).
**Procedure**

All participants were familiar with the 6MWT of the Senior Fitness Test, having completed this test battery 3 and 12 months before the current study. Thus, practice trials were not used here. For this study, two 6MWT were administered 2–9 days apart. One 6MWT followed the protocol of the Senior Fitness Test (Rikli & Jones, 2001) and consisted of walking around a 20- by 5-yd rectangle (i.e., 50-yd perimeter) outdoors on a flat concrete surface. Orange cones marked the corners and perimeter of the rectangle. The other 6MWT followed the same protocol except the participants were required to walk around an indoor oval track with a rubberized surface (circumference 144.3 yd). The order of testing was randomized and counterbalanced; however, varying weather conditions and participant absences necessitated rescheduling the tests, and 75% of the participants completed the rectangular configuration first. Test conditions were comparable: Ambient temperature and relative humidity were similar for both tests, the tests were administered at the same time of day, seating was provided for those who needed to rest, and similar verbal encouragement was given for both conditions (“Way to go,” “Good job”). Participants were given straws for each completed circumference of the oval or rectangle as they passed the start line. These were added together and multiplied by the distance of the circumference of the configuration that had been walked. Partial circumferences were measured with a measuring wheel from the start point to where the participant stopped at the end of the test. All tests were administered by two health and fitness instructors certified by the American College of Sports Medicine, both with graduate degrees in related fields.

**Statistical Analyses**

Comparability was assessed using two techniques. First, an intraclass correlation coefficient (R) was determined for the distances walked with the two configurations. Second, a Bland–Altman plot was used to assess the degree of agreement, or the variability across the range of measurements, between the two 6MWTs (Bland & Altman, 1986). The limit of agreement was considered the mean difference between the two 6MWT distances ± 2 SD of the difference (Bland & Altman). A paired-samples t test was used to compare the distance walked between the two configurations. Finally, stepwise linear-regression analysis was used to determine the extent to which responses to the rectangular configuration could be predicted from the oval configuration. Data are expressed as M ± SEM.

**Results**

Participants walked 582 ± 16 yd and 639 ± 19 yd when completing the rectangular and oval 6MWT, respectively (p < .0001), or 10% ± 2% farther with the latter configuration. The distances walked for the two 6MWTs were internally consistent, \( R = .95, .91–.98 \) (95% confidence interval). The Bland–Altman plot is shown in Figure 1. The limits of agreement suggest that the 6MWT distance for the
rectangular configuration of the Senior Fitness Test could be expected to range from 29 yd above to 143 yd below that of the oval-track configuration. Responses to the rectangular configuration could be predicted from the oval configuration by the equation 66.7 yd + 0.807 × (walking distance on the oval track), $R^2 = .85$.

**Discussion and Conclusion**

The purpose of the current study was to determine the comparability of two 6MWT configurations. The rationale for the study was that, despite the widespread use of the 6MWT in fitness test batteries of older adults, very little research has assessed how different configurations affect 6MWT performance. The important findings of the current study are (a) the configuration of the 6MWT has a substantial influence on the distance walked, yet (b) the responses to the different configurations are internally consistent. In other words, between-participants comparisons of 6MWT performance should be made with caution if the test format differed between participants. The large limits of agreement seen here suggest that these two 6MWT configurations should not be viewed as interchangeable. Nevertheless, meaningful comparisons can be readily made if the test format does not differ.

Our findings largely parallel those of Sciurba and colleagues (2003), who conducted the only similar study to date. They found that walking with minimal directional change resulted in ~10% greater performance over configurations
consisting of directional changes. Their cohort differed markedly from the group assessed in the current study in that all their participants had COPD such that 11% required oxygen at rest and 78% required it during the 6MWT. Our participants were physically active, with an estimated VO2peak of 30.1 ± 1.2 ml · kg⁻¹ · min⁻¹, and were able to walk ~51% farther than the COPD cohort. Both groups were similar in age. Collectively, these data suggest that, over a wide range of walking abilities, a course configuration that allows gradual turns appears to result in 6MWT distances that are ~10% better than walking on a course that necessitates more abrupt directional change.

A 10% difference is statistically and functionally meaningful. For example, based on the 6MWT distances walked with the rectangular configuration, our participants were in the 56 ± 4 percentile of performance compared with peers similar in age and gender (Rikli & Jones, 1999b; 2001). These normative scales were developed using this rectangular configuration. If these normative scales were blithely applied to the 6MWT distances achieved using the oval configuration, our participants would appear to exhibit markedly higher cardiorespiratory fitness, being in the 70 ± 5 percentile, or ~25% better. Clearly, the few days that separated these two assessments could not have enabled such marked improvements in cardiorespiratory fitness. This improvement was also likely not the result of a learning or practice effect. The participants had completed the Senior Fitness Test twice previously, so they were familiar with the testing process. They were also physically active, having been engaged in a program of structured exercise for the previous year. For most of these participants, this program regularly included continuous walking, such as encountered with the oval 6MWT configuration. The participants were comfortable completing the 6MWT with both course configurations. Thus, the 10% difference very likely reflects performance differences caused by the two 6MWT configurations.

Although the oval configuration yielded greater 6MWT distances in this study, the most extensive normative data for the 6MWT are those developed using the rectangular configuration of the Senior Fitness Test. Thus, for comparing a given cohort to a larger, more representative sample of older adults, the rectangle might be the preferred configuration. To that end, we developed a simple regression equation that can be used to equate performance on an oval walking course to that on the rectangular course. Although this equation needs to be validated in another cohort of older adults before it can be fully adopted, it explains fully 85% of the variance between the two 6MWT configurations.

Several limitations to the current study need to be appreciated. First, our participants were unique. They were already physically active, having been in a supervised exercise program for a year, and most were above average in fitness for their age group. Our findings might therefore not be applicable to a group of older adults with lower cardiorespiratory fitness, although the largely comparable findings of Sciurba and colleagues (2003) suggest that generalization can be done with caution. Second, it is unclear whether our findings would be comparable to other course configurations. The gentle curves and large size of the oval track used here likely enhance the comparison of this course configuration with other nonangular walking arrangements, such as walking along a neighborhood sidewalk. To our knowledge, however, this comparison has yet to be made. The surface differences might have contributed to the different scores, because the thin rubberized
surface over the concrete oval track would have been slightly more resilient than the plain concrete surface in the rectangular configuration. Finally, the participants commented that the oval track was easier to navigate than the right turns of the rectangle relative to their joint mobility.

In summary, using physically active older participants, we tested the comparability of a 6MWT completed by walking in an oval configuration to one requiring right-angle directional changes. The participants were able to walk statistically significantly farther on the oval course. The high internal consistency of the 6MWT distances on the two courses, however, suggests that the differing course configurations affected the participants equally. These data suggest that assessing 6MWT performance using a course requiring no marked changes in direction necessitates a correction factor when comparing these results with normative data obtained using a rectangular configuration (i.e., that of the Senior Fitness Test; Rikli & Jones, 2001). Therefore, the testing configuration needs to be considered when comparing results from different studies.

Acknowledgments

The authors thank the participants for their cheerful cooperation. This project was supported by NIH Grant R01 AI49956 and presented in part at the 51st annual meeting of the American College of Sports Medicine, Nashville, TN, June 2005.

References


