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The Modified Total Body Rotation Test: A Rapid, Reliable Assessment of Physical Function in Older Adults

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Abstract

OBJECTIVES—To describe a quick, modified measure of total body rotation with performance rankings for elderly persons and to highlight the importance of total body rotational ability for overall physical performance.

DESIGN—Scores were collected during the same testing session and were compared with other measures using a Pearson correlation.

SETTING—Community-based senior centers.

PARTICIPANTS—One hundred forty-five participants aged 79.6 ± 7.2 were recruited using flyers distributed at health fairs, senior centers, and lifelong learning programs.

MEASUREMENTS—The modified total body rotation test (MTBR), the back-scratch test, the modified sit-and-reach test, the 30-second chair-stand test, the Short Physical Performance Battery, and the short version of the Continuous-Scale Physical Functional Performance Test.

RESULTS—The MBTR significantly correlated to all standard measures of physical performance. Norms are reported for all participants, and reliability analyses were conducted using data from 18 participants. Data were divided into quintiles to create cutoffs for physical performance rankings that can be used when reporting results to the general public.

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CONCLUSION—Many evaluations measure isolated components of physical performance, but few examine whole body movements that allow all components necessary for independence and function to work in harmony as needed considering the task and the individual's movement strategy. The current study offers the MTBR as a quick, easy, and cost-effective evaluation method to quantify the degree of impairment or injury and the rate of improvement with treatment or training.

Keywords

range of motion; axial rotation; assessment; flexibility; physical function

Rotational ability and axial range of motion (ROM) are strongly associated with physical or functional performance.¹⁻³ Rotational movements are required for many activities of daily living, although rotational flexibility is commonly overlooked and undervalued in fitness evaluations and training programs.^{1,2,4-9} Rarely are common movements performed in a single plane or using a single joint; rather, everyday tasks require the use of multiple muscle groups in multiple planes of movement and usually involve body rotation.^{4,5,9} For example, common tasks such as sweeping the floor, transferring objects from one surface to another, and doing laundry involve trunk rotation.

A single performance measure that can provide information on all joints involved in the sequential and synchronized joint movements that are commonly incorporated in daily activities would provide a practical, inexpensive, and clinically relevant assessment and would be quicker and easier to perform than a multitest battery.^{7,9-12} A measure like this would benefit healthcare personnel and patients by reducing time demands and costs.^{10,11} This article draws a significant link between total body rotation and physical performance; describes a new, modified method of assessment; reports reliability levels for the method; and establishes performance rankings that can potentially be used to evaluate and benchmark performance, injury, and recovery.

METHODS

Participants

Participants from south Florida were recruited for the study using flyers distributed at health fairs, senior centers, and lifelong learning programs. To determine performance rankings for the modified total body rotation test (MTBR), participants were divided into three age groups: 65 to 74 (n = 34), 75 to 84 (n = 74), and 85 and older (n = 37). Participants had to be aged 65 and older and willing to travel to the testing site. Exclusion from participation was limited to self-assessed inability to perform tests individually, so a participant could be excluded from performing one measure but not from other measures or the total analysis. Before participating in the study, all participants read and signed a consent form that the University of Miami Subcommittee for the Use of Patients or Human Subjects, the Miami Jewish Health System Committee for the Use and Protection of Human Subjects, the Bruce W. Carter Department of Veterans Affairs Medical Center institutional review board, or the Florida Atlantic University institutional review board approved.

Procedures

The MTBR is a modification of a test originally designed to measure the rotational flexibility of the whole body.⁴ In the original version, the participant stands an arm's length away from a wall and rotates *away* from the wall while trying to reach back and along the wall as far as possible using the arm on the side of the body opposite the wall without moving his or her feet or bending the elbow of the outstretched arm.⁴ The tester measures

how far forward (anteriorly to the original stance) the hand reaches on the wall.⁴ For the current study, the modified procedure described elsewhere (Figure 1) was used.¹³ Participants stood next to the wall without touching and rotated *toward* the wall as the tester measured how far back (posterior to the original stance) participants could reach without moving their feet.¹³ This modification was made to increase safety, increase subject confidence, and reduce any basement effect that might exist with an older population.¹³ The examinee stood with the front of the shoes at a line marked on the floor.¹³ Two measuring tapes were fastened to the wall, with the zero points at the line on the floor and the ends extending in opposite directions to be able to measure rotation to either side.¹³ Reach was measured to the nearest half inch (1.27 cm), and scores for the preferred side were used in the analyses.¹³⁻¹⁵ A subsample of the participants was asked to return on another day to conduct a test-retest reliability analysis, and was by a separate examiner performed all retesting to determine interrater reliability. Test-retest reliability statistics were calculated for the 18 participants (12 women, 6 men, aged 69.6 ± 10.1) who agreed to come back to be retested. Cronbach alphas were calculated for participants' scores during the initial testing period and during the retesting, which occurred approximately 2 weeks later.

The other measures used to assess the validity of the MTBR were conducted according to methods described in the literature for measuring a variety of components that contribute to functionality and measures of physical function.¹⁵⁻¹⁸ The back-scratch and modified sit-and-reach tests are measurements of flexibility of the lower back and hamstrings and the shoulders, respectively.¹⁵ The gallon-jug shelf task involves upper body and core power (work rate), rotational stability, and some dexterity. The 30-second chair-stand test is a common measure of lower body strength and power. The test measures how many times a person can rise from a chair within a fixed time period. Because the test is based on total work performed in a fixed period, it can be concluded that the test involves a large power (work rate) component.

The Short Physical Performance Battery (SPPB), which was compared with the MTBR, is a well-documented, well-accepted measure of total physical function. The SPPB provides a total score from 0 to 12 that indicates an individual's physical ability. The measure consists of three constructs representing gait, balance, and ability to rise from a chair. Points are awarded according to the person's performance and then tallied to give the total SPPB score.

The Continuous-Scale Physical Function Performance Test short version (PFP-10) was correlated to the MTBR.¹⁸ This measure consists of 10 activities commonly performed in everyday life. It is a validated functional measure and one of the most complete testing batteries for evaluating typical household tasks. Thirty-six of the 145 participants were asked to complete the PFP-10. The tasks included carrying a pan for 1 m, donning and removing a jacket, floor sweeping with a broom and dustpan, transferring clothes from a washer to a dryer and a dryer to a basket, picking up four scarves from the floor, carrying groceries for 70 m, sitting on and standing up from the floor, climbing stairs, and walking for 6 minutes.¹⁸

Statistical Analyses

The MTBR was compared with the six other measures of performance using a Pearson correlation. Percentiles were calculated for each age group and for the entire sample. All statistics were calculated using PASW Statistics version 17.0 (release 17.0.2, SPSS, Inc., Chicago, IL). Alpha levels were set to 0.05. To establish reliability of the MTBR, Cronbach alphas and Student pairwise *t*-tests were calculated using data collected on separate days by a different examiner.

RESULTS

A sample of 145 participants (73 men, 72 women) aged 79.6 ± 7.2 from a south Florida community were enrolled in the study. To determine performance rankings for the MBTR, participants were divided into three age groups: 65 to 74 ($n = 34$), 75 to 84 ($n = 74$), and 85 and older ($n = 37$).

One-tailed correlation coefficients are reported in Table 1. The MBTR correlated significantly with all of the other standard measures of physical performance and function, including the back-scratch ($P < .001$), the modified sit-and-reach ($P < .001$), the gallon-jug shelf transfer ($P < .001$), and the 30-s chair-stand ($P < .001$) tests; the SPPB ($P = .002$); and the PFP-10 ($P < .001$). When test-retest data were analyzed using a Student pairwise *t*-test, the scores from the initial data collection and the subsequent collection did not differ significantly ($P > .05$). Cronbach alpha was 0.924, which is acceptable for determining the reliability of the measure.

The average score for all participants on the MBTR was 23.8 ± 4.3 inches (95% CI=23.1–24.5 inches) (60.5 ± 10.9 cm, 95% CI=58.7–62.2 cm). Scores were not significantly different according to sex, which is consistent with reported similarities in spinal mobility between men and women.¹⁰ The sexes were combined within each age group and divided into quintiles. Scores were different between the oldest group and the groups aged 65 to 74 ($P = .002$) and 75 to 84 ($P = .01$). Quintiles and the associated rankings previously listed according to age are reported in Table 2. Rankings were excellent (highest quintile), good (second-highest quintile), average (middle quintile), fair (second-lowest quintile), and poor (lowest quintile). Participants scoring in the good or excellent categories on the MBTR (60th percentile or higher) performed significantly better on the SPPB ($P = .002$).

DISCUSSION

The current analysis provides support for an additional diagnostic or screening measure for predicting overall physical performance. The test is quick and easy to perform and requires less equipment than other measures of axial rotation. Also, because the test does not restrict twisting or reaching strategies in participants, it may be more appropriate for assessing everyday functional abilities than more-restrictive tests that do not allow multiple strategies for task completion.⁷ It is also likely that the MBTR provides a more clinically relevant result for the practitioner during diagnosis and prescription of treatment or training.^{7,11,12}

The significant relationship between the MBTR and other measures of ROM is not surprising, because the MBTR is a summation of the cumulative ROM of many different body joints (shoulder girdle, shoulder, ribs, spine, hips, knees, and ankles). For examples, the test involves shoulder elevation and protraction, which are present in the movement of the overhead arm during the back-scratch test, and the movement of the pelvis, twisting of the lower back, and stretching of the hip extensors, which are measured during the modified sit-and-reach.¹⁵ The correlation between the MBTR and the modified sit-and-reach is in agreement with other reports that found moderately strong correlations between axial ROM and ability to reach one's big toe.³

Because flexibility is a joint-specific component of total fitness, multiple measures have traditionally been used to assess flexibility fully without regard to the contribution of one body part's ROM to an entire functional movement. Therefore, the MBTR, by involving all joints as they are used in a complete movement, may be most appropriate in assessing an individual's true, total flexibility.

A person's ability to perform the MBTR does not depend solely on flexibility. Comparing the MTBR with measures that incorporate a broad spectrum of abilities demonstrates its value as an additional measure of overall function. Again, because multiple components are used simultaneously during a functional movement, measures of function should also require different abilities to be used together for successful execution. For example, during the gallon-jug shelf task, the individual must have enough lower body strength to support the upper body and serve as an accessory muscle while reaching, shifting body weight, and maintaining balance.^{1,3,16} Positive and significant links to the SPPB and the PFP-10 support the use of the MBTR as an additional measure to screen for vulnerability or to assess function, injury, and improvement with treatment. The SPPB has been shown to have a strong association with self-reported disability and physical function.¹⁷ For example, the ability to rise from a chair has been described as one of the most common activities of daily living and one of the most important tasks addressed in therapy.¹⁹ Additionally, the SPPB can be applied to most levels of functional ability, so it is effective at predicting functional status, mortality, and institutionalization in a large portion of the elderly population.¹⁷ The data from the current study, linking the ability to perform repeated chair stands quickly to MTBR performance, help to confirm the MTBR as an important measure of multiple components of physical performance by providing evidence that abilities required for repeated chair stands are one of many required for the MBTR.

Additionally, the correlation between the MBTR and the PFP-10 battery shows the generalizability of the capacity to rotate the body around its base while maintaining an upright position to everyday tasks such as carrying objects, performing household chores, and dressing oneself.¹⁸ This link, along with the significant correlations with other measures of physical performance and function, especially the SPPB, argues for the potential for the MTBR to be an important tool for measuring or evaluating a person's capabilities in everyday life.

The culmination of this analysis was the development of simple rankings for use with men and women aged 65 and older. Participants unable to score in the top two quintiles (excellent or good rankings) could be identified as needing further testing, because those scoring less than the 60th percentile performed significantly worse on the SPPB ($P=.002$). Exercise professionals, clinical and extended-care facilities, healthcare providers, therapists (physical, occupational, recreational), and researchers may use these rankings in communicating to participants how well they did when performing the assessment and may be used for setting goals for treatment or training.^{4,11} These goals may be more understandable than pure percentiles or even a "1-to-10" scale, since these could be confused with the academic grading system, under which scores less than 70% or 80% could be interpreted as "weak." Exercise professionals and personal trainers may choose to use the test in conjunction with other measures to confirm the findings for their clients, who may need multiple indicators that physical performance or fitness has declined.^{10,11} The rankings may also be used during retesting of the client to track progress.^{10,11}

Clinics or extended-care facilities with limited resources can use this cost-effective indicator of physical performance to identify those at risk for functional declines.^{2,9-12,20} Healthcare providers may also use these rankings in describing to a patient a physical performance detriment for which an intervention may be needed.^{10,11} Therapists may evaluate the degree of effect on total function caused by an injury to an area of the body using MTBR scores. The rankings (and percentiles) can also be used to set goals for improvement and to track progress (using benchmarks) in treatment. If the value of the total body rotation movement is accepted into practice, then practitioners may in the future require an individual's rotational ability to be in the excellent or good range before discharge from treatment. This requirement would be in addition to current practices of improving the patient's ability

(using lower-body strength, lower-body power, balance, and coordination) to perform basic tasks such as rising from a chair. The simple, quick, and inexpensive MBTR is made up of many components, all of which are used in whole-body functional movements, making it a valuable method of measuring function and physical performance in older populations. Researchers examining the effects of specific exercise interventions or nutritional treatments may use the MTBR as an evaluative tool to determine the effectiveness of current practices compared to new or alternative treatments.^{10,11}

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Figure 1. Performance of the modified total body rotation test: (A) setting foot position, (B) setting distance from the wall, (C) conducting the test.

Table 1
Correlation Between the Modified Total Body Rotation Test and Other Measures of Functionality and Physical Performance

Measure	Correlation Coefficient	P-Value
Back-scratch test ¹³	0.309	<.001
Modified sit-and-reach ¹³	0.272	<.001
Gallon-jug shelf transfer ¹⁴	−0.342	<.001
Thirty-second chair stand ¹³	0.419	<.001
Short Physical Performance Battery ¹⁵	0.307	.002
Continuous-Scale Physical Function	0.732	<.001
Performance Test short version total score ¹⁶		

Table 2
Minimum Scores for Each Ranking and Quintile of the Modified Total Body Rotation
Test According to Age

Percentile Rank	Inches			
	65–74 (n = 34)	75–84 (n = 74)	>85 (n = 37)	All (N = 145)
≥80 (excellent)	≥28.5	≥28.5	≥26.0	≥28.0
60–79 (good)	26.9	26.1	22.3	25.9
40–59 (average)	25.1	23.6	20.1	23.0
20–39 (fair)	22.1	20.3	18.0	19.5
<20 (poor)	<22.1	<20.3	<18.0	<19.5