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Values for timed limb coordination tests in a sample of healthy older adults

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Abstract

Background: Timed limb coordination tests are reliable measures of motor performance but many lack published reference values.

Objective: To determine mean values for timed tests in an older cohort, examining associations with anthropometric characteristics, handedness, gender and age.

Design: Cross-sectional.

Setting: Community.

Subjects: Sixty-nine healthy adults divided into three groups: 60–69, 70–79 and 80+ years.
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Methods: height, weight and time to complete five repetitions of finger-to-nose, pronation–supination, mass grasp, opposition and heel-on-shin were recorded. Performances were statistically compared with anthropometric characteristics, handedness and across age groups and gender.

Results: for all tests, height negatively correlated with speed (r = −0.26 to −0.41). Weight negatively correlated with performance of two tests (r = −0.25 to −0.35). When covariates were controlled, men performed heel-on-shin faster than women. The youngest group completed upper extremity tests faster than the oldest. Adults in their 70 s completed finger-to-nose and pronation–supination faster than persons aged 80+ years.

Conclusions: we report mean values for five clinical tests of timed limb coordination that may aid in identifying mild deficits in otherwise healthy older adults.

Keywords: coordination, psychomotor performance, neurological examination, older people

Background and purpose

Timed limb coordination tests are reliable measures of motor performance [1, 2] that are clinically useful. They can differentiate persons with Alzheimer’s disease [3] or Parkinson’s disease [4] from age-matched controls. Increased disease severity has been revealed by slower speed of performance in patients with pulmonary disease [5]. The effectiveness of botulinum toxin for spasticity and deep brain stimulation for dyskinesias is reflected by changes in timed performance [6, 7]. Coordination speed is even able to predict social participation years after a stroke [8].

The drawback of timed coordination measures is their lack of reported reference values [9]. Only two, finger tapping and finger-to-nose, have published norms. The number of finger taps in 10 s has been documented [10, 11], but a lever was used to record tapping strokes. Instrumentation improves test reliability [12], but is inconvenient and impractical in some settings. Two studies reported timed finger-to-nose (starting position: 90° shoulder flexion, fingers extended, no target) for persons in their teens to mid-30 s [13, 14]. Average time to complete five repetitions differed by one-half to 1 s between the reports, possibly due to the use of athletes in the study with faster results. Since timed performance decreases with age [15], times recorded for younger subjects are not applicable to older age groups. The only study to quantify the finger-to-nose test in older persons counted the number of repetitions completed in 20 s and had subjects alternately touching their nose and a wall target [16]. Most investigators time five cycles and do not use a wall target [1, 13]; therefore, the published values are not reflective of usual practice.

The purposes of this study were to determine mean values for five timed limb coordination tests in a healthy older cohort, and to determine whether timed performance is associated with anthropometric characteristics [height, weight, body mass index (BMI)], influenced by hand dominance or age, or differs between genders. Findings from this study may provide references for clinicians to compare patient performance on the examined tests to aid in identifying impaired limb function.

Methods

Participants

This study was approved by the Mayo Clinic Institutional Review Board. Based on an a priori power analysis, a minimum of 54 participants distributed across three age groups (60–69, 70–79, 80+) and both genders was indicated to detect effect sizes of 0.50 at α = 0.05 at a statistical power (1 – β) of 0.90 to protect against Type II error. Recruitment flyers and word-of-mouth were used to recruit subjects around Rochester, MN. Males and females were recruited in equal numbers, since a gender difference has been reported for timed coordination tests [15]. Figure 1 depicts the sampling process, inclusion criteria and age group assignments. Interested subjects were screened for eligibility by phone and re-verified on the day of testing. Sixty-nine participants were eligible and provided written consent.

Data collection

Weight and height were recorded. Hand dominance was determined by the hand used for writing. Five repetitions of finger-to-nose, pronation–supination, mass grasp, finger opposition and heel-on-shin were timed using a stopwatch. These five tests have reported high inter-rater reliability coefficients even among persons of different levels of experience and backgrounds (intra-class correlation coefficients of 0.89–0.97) [17]. For test descriptions, see Supplementary data available in Age and Ageing online, Appendix 1, and for test choice justification, see Supplementary data available in Age and Ageing online, Appendix 2.

Participants were seated during upper extremity tests and supine for heel-on-shin. Visual demonstration with verbal instruction of each measure was provided. Two timed trials were completed. The second was used for analysis, since a prior study found subjects performed faster during a second but not a third trial of coordination testing [14]. If the best effort was not given during the second trial, a third was completed and the fastest used for analysis. Participants performed each task until told to stop to ensure full speed throughout the tests, but only the first five cycles were timed.
Data analysis

Descriptive data stratified by age group, gender and hand dominance were calculated. Relationships between test performance and participants’ anthropometrics were examined with Pearson product-moment correlation coefficients, effects of hand dominance using paired t-tests and effects of age and gender with 3×2 analyses of covariance and Bonferroni adjustments. Anthropometric data that correlated with coordination performance were included as covariates. We used family wise α = 0.05 for all statistical tests.

Results

Sample characteristics

Descriptive data and mean times for test performances across age groups and gender are presented in Table 1. Mean height and weight, but not BMI, differed significantly across genders and age group. Men were taller and heavier than women (P < 0.001). Persons in the youngest group were taller (P = 0.013) and heavier (P = 0.023) than persons in the oldest group.

Test performance and anthropometric characteristics

Height negatively correlated with performance time for all tests (r = -0.26 to -0.41). Pronation–supination and mass grasp timed performance negatively correlated with participants’ weight (r = -0.25 to -0.35). There was no effect of weight on performing the remaining tests, or of BMI on any test (for correlation coefficients and P-values between participant anthropometrics and timed coordination test performance, see Supplementary data available in Age and Ageing online, Appendix 3).

Handedness, gender and age effects

Handedness had no effect on timed performance (P = 0.086, 0.058, 0.071, 0.383 and 0.859 for the finger-to-nose, pronation–supination, mass grasp, finger opposition and heel-on-shin tests, respectively). Men performed faster than women during pronation–supination (P = 0.005), mass grasp (P = 0.005) and heel-on-shin (P = 0.006) tests, but once height (all tests) and weight (pronation–supination and mass grasp) were controlled, men and women differed only in heel-on-shin performance (Table 1). Performance times were slower in the 80+ group than the 60–69 group across all upper extremity tests, and slower in the 80+ group than the 70–79 group in the finger-to-nose and pronation–supination tests (Table 1). Test performances between the 70–79 and 60–69 groups did not differ.

Discussion

We report time-to-complete five repetitions of five common limb coordination tests in a healthy cohort over 60 years of age. Patient performance times could be compared with these to identify possible deficits or set goals. Published values for objective measures are important, since healthy older adults have variable performance that subjective assessment may surmise as pathologic [18].

Of the tests examined, reference values are available only for finger-to-nose. In a 2005 study [19], persons up to age 63 years completed the test in 3.49–4.09 s. Their fastest reported time is similar to persons in our 60–69 year group who averaged 3.5–3.7 s to complete five repetitions.

We found height to be advantageous for moving faster. Prior timed coordination studies have not reported such an effect, unlike gait speed in which taller subjects walked faster [20]. Increased body weight resulted in faster pronation–supination and mass grasp performance. Perhaps increased soft tissue decreased total range of motion needed to fully complete these tests, increasing the apparent speed at which they can be performed. A 2010 study[13] found BMI negatively affected time to complete finger-to-nose, but BMI had no effect on limb speed in
Table 1. Means and standard deviations (SD) for demographic and anthropometric characteristics of the study sample, along with adjusted performance times for five timed tests of limb coordination

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60–69</td>
<td>70–79</td>
</tr>
<tr>
<td></td>
<td>n = 12</td>
<td>n = 12</td>
</tr>
<tr>
<td>Age (years)</td>
<td>66.2 (2.7)</td>
<td>73.3 (2.0)</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>163.3 (4.4)</td>
<td>159.4 (6.3)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>73.4 (10.2)</td>
<td>70.8 (10.5)</td>
</tr>
<tr>
<td>BMI</td>
<td>27.5 (3.3)</td>
<td>27.8 (3.4)</td>
</tr>
<tr>
<td>Finger-to-nose*</td>
<td>3.6 (0.9)</td>
<td>4.0 (1.0)</td>
</tr>
<tr>
<td>Pronation–supination**</td>
<td>2.9 (0.6)</td>
<td>3.2 (0.6)</td>
</tr>
<tr>
<td>Mass grasp***</td>
<td>2.4 (0.7)</td>
<td>2.8 (0.8)</td>
</tr>
<tr>
<td>Finger opposition****</td>
<td>6.3 (1.7)</td>
<td>7.2 (1.9)</td>
</tr>
<tr>
<td>Heel-on-shin******</td>
<td>4.3 (0.9)</td>
<td>4.8 (1.1)</td>
</tr>
</tbody>
</table>

Times are reported in seconds. Since times between dominant and non-dominant extremities were not significantly different, adjusted performance times are reported only for the dominant extremity; cm, centimeter; kg, kilograms.

*Finger-to-nose performance, adjusted for height, differed between age groups (P = 0.003) but not between genders (P = 0.640). Performance was slower in the 80+ group than in the 70–79 group (P = 0.036) and in the 60–69 group (P = 0.003). Performance in the 70–79 and 60–69 age groups did not differ (P = 0.957).

**Pronation-supination performance, adjusted for height and weight, differed between age groups (P = 0.006) but not between genders (P = 0.208). Performance was slower in the 80+ group than in the 70–79 group (P = 0.041) and in the 60–69 group (P = 0.006). Performance in the 70–79 and 60–69 age groups did not differ (P = 1.000).

***Mass grasp performance, adjusted for height and weight, differed between age groups (P = 0.038) but not between genders (P = 0.439). Performance was slower in the 80+ group than in the 60–69 group (P = 0.035). Performance in the 70–79 and 60–69 age groups did not differ (P = 0.988), nor did performance in the 80+ and 70–79 age groups (P = 0.226).

****Finger opposition performance, adjusted for height, differed between age groups (P = 0.003) but not between genders (P = 0.837). Performance was slower in the 80+ group than in the 60–69 group (P = 0.002). Performance in the 70–79 and 60–69 age groups did not differ (P = 0.312), nor did performance in the 80+ and 70–79 age groups (P = 0.112).

*****Heel-on-shin performance, adjusted for height, differed between genders (P = 0.033) but not between age groups (P = 0.228).

our cohort, which was older (mean 22 versus 73.7 years) with a larger average BMI (23.5 versus 27.7).

Performance did not vary significantly according to handedness, unlike previous studies [13, 14, 16]. While men performed heel-on-shin faster than women, gender did not play a role in upper limb performance once height and weight were controlled. Prior investigators found men faster than women in timed tasks [13, 16]. However, these reports do not appear to have considered how height and weight may have accounted for group differences. Analysis for potential effects of height on timed performance warrants further study.

Over a lifetime, timed performance becomes fastest during the teen years through the third decade of life [2, 13, 14]. Performance time begins to slow by 40–50 years of age depending on task and gender [10, 15]. Ours and previous findings [16] suggest that slowing continues with age and significantly so after the age of 80 for many timed coordination tasks.

Limitations

Results are based on a small sample of healthy adults and may not generalise to subjects in poor health, frail or institutionalised. Slower speed of performance from these groups may not reflect neuromuscular impairment, therefore, validation studies with larger samples across a variety of older adults are needed. Finally, speed is just one aspect of coordination to assess; it may not correlate with quality of movement.

Key points

- We report mean values for five timed limb coordination tests that may help identify mild deficits in otherwise healthy older adults.
- Taller subjects had faster limb coordination test times.
- Upper limb performance was significantly slower after age 80.

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Supplementary data

Supplementary data mentioned in the text is available to subscribers in Age and Ageing online.

References

We surveyed a sample of patients attending urology outpatient clinics in a one week period.

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