Adult Norms For The Nine Hole Peg Test Of Finger Dexterity

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The purposes of this study were to establish standardized procedures for the Nine Hole Peg Test of finger dexterity, to evaluate its reliability and validity, and to establish new clinical norms based on these standardized procedures. For the reliability and validity study, 26 female occupational therapy students were tested. Very high interrater reliability (right r = .97, left r = .99) was found. Test-retest reliability was reported to be moderate to high (right r = .69, left r = .43) and a significant practice effect was found between the test and retest occasions. Possible variables that may have affected these results are discussed. To evaluate concurrent validity, the Nine Hole Peg Test was compared to the Purdue Pegboard. The observed correlations (right r = −.61, left r = −.53) indicated that the tests are similar but not equivalent tests of finger dexterity. For the normative data study, 628 normal subjects from 20 to 94 years were tested. Data were stratified by sex and by 12 age groups to allow the therapist to easily compare patients' scores to a normative population. Data showed that females scored slightly better than males, finger dexterity decreased with age, and right-hand and left-hand dominant subjects demonstrated minimal differences in performance.

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The Nine Hole Peg Test is commonly used by occupational therapists as a quick measurement of finger dexterity. A relatively inexpensive construction cost and brief administration time may account for its widespread use. Only one published report on the Nine Hole Peg Test was found (Kellor, Frost, Silberberg, Iversen, & Cummings, 1971). That study used a sample of 250 males and females, stratified by sex and three large age groups. Normative data based on regression analysis were provided for 20- to 80-year-old adults in 5-year intervals. The norms were presented in tabular form, facilitating comparison of patient scores with normal individuals of the same age and sex. A description of the pegs and pegboard was provided, but the container for the pegs was not described in sufficient detail to be replicated. The general procedure for testing was described, but there were no standardized instructions reported. In addition, no reliability or validity data were reported in the article. Due to these limitations, the validity of the Nine Hole Peg Test and its available norms were seriously compromised.

An alternative measurement of finger dexterity is the Purdue Pegboard, which has been standardized for factory workers in a wide variety of industrial jobs. Reliability and validity data have been reported, and normative data have been established for various employee groups (Tiffin, 1968) and school children (Gardner & Broman, 1979). Unfortunately, normative data are lacking for a general adult population. For clinicians, perhaps the most obvious limitations of the Purdue Pegboard is that the normative data for factory workers poorly represent the older adults seen in most physical disabilities clinics. In addition, the test in its entirety is somewhat lengthy to administer.

Table 1
Characteristics of Subjects: Age, Sex, and Hand Dominance

	Males				Females			
Age Range	N	Mean Age	Right[a]	Left[a]	N	Mean Age	Right[a]	Left[a]
20–24	29	21.7	26	3	26	22.4	26	0
25–29	27	27.4	21	6	27	26.6	25	2
30–34	27	32.1	24	3	26	32.1	23	3
35–39	25	37.3	24	1	25	36.4	17	8
40–44	26	41.5	22	4	31	42.3	30	1
45–49	28	47.1	28	0	25	47.1	25	0
50–54	25	51.9	25	0	25	51.9	22	3
55–59	21	57.1	21	0	25	56.5	25	0
60–64	24	62.1	22	2	25	62.4	24	1
65–69	27	66.7	27	0	28	67.3	25	3
70–74	26	72.0	23	3	29	71.8	28	1
75+	25	78.9	25	0	26	78.8	25	1
Total	310		288	22	318		295	23

[a]Right-hand or left-hand dominance.

from 20 to 59 years of age were free from disease or injury that could affect their dexterity. The following less stringent criteria were followed for subjects over age 60: (1) no acute pain present in their arms and hands; (2) at least 6 months post-hospitalization (i.e., heart attack or any surgery); (3) maintained a normal lifestyle (i.e., subject had not had restricted activity level because of a health problem). Consequently, people with degenerative joint disease who were not currently experiencing pain and who were maintaining their normal activity level were included in this study. The rationale for using these less stringent criteria is that people of this age group frequently have some chronic health problems (Jack & Ries, 1981).

A brief interview preceded all the testing procedures to determine if subjects met the above criteria. The subject's name, age, sex, hand dominance, and occupation were recorded. Hand dominance was determined by asking, "Are you right-handed or left-handed?" If the subject reported they used both hands equally, the hand used to write was determined to be the "dominant" hand. This study was part of a larger study of hand strength and dexterity (Mathiowetz, Kashman, Volland, Weber, Dowe, & Rogers, in press; Mathiowetz, Volland, Kashman, & Weber, in press). The Nine Hole Peg Test was the first test administered in a series of tests. It was followed by a test of manual dexterity, the Box and Block Test, and

Table 2
Test-Retest Reliability of Nine Hole Peg Test
for 27 Females, Ages 20–39,
Using the Pearson Correlation Coefficient

	Test			Retest			
	M	SD	SE	M	SD	SE	Correlation
Right	16.1	1.8	.35	15.2	1.6	.32	.693**
Left	18.7	3.6	.70	17.1	2.2	.43	.428*

*$p<.05$.
**$p<.001$.

four tests of hand strength. The latter were administered after the two dexterity tests to avoid having fatigue affect the dexterity test scores.

RESULTS

Reliability and Validity Study

A very high interrater reliability (right $r = .97$, left $r = .99$) was obtained using the Pearson correlation coefficient. Test-retest reliability was high ($r = .69$) for the right hand and moderate ($r = .43$) for the left hand (Table 2). Using the same test-retest reliability data (Table 2), a two-tailed, paired data t test was used to evaluate the practice effect between the two occasions for each hand. A significant difference was noted for the right hand ($p<.001$) and for the left hand ($p<.05$). A Pearson correlation coefficient was used to assess the concurrent validity of the Nine Hole Peg Test with the Purdue Pegboard as the parameter. A significant inverse relationship was obtained for the right hand ($r = -.61$) and the left hand ($r = -.53$). An inverse relationship was expected, because the lower the score on the Nine Hole Peg Test, the better the performance, whereas on the Purdue Pegboard, the higher the score, the better the performance.

Normative Study

The average performance of males on the Nine Hole Peg Test is reported in Table 3 and the average performance of females in Table 4. For both males and females, the 20–24 age group demonstrated the highest performance (lowest score), and the 75+ age group demonstrated the lowest

Table 3
Average Performance of Normal Males
on the Nine Hole Peg Test (time in seconds)

Age	Hand	Mean	SD	SE	Low	High
20–24	R	16.1	1.9	.35	13	22
	L	16.8	2.2	.41	13	23
25–29	R	16.7	1.6	.31	14	21
	L	17.7	1.6	.31	15	21
30–34	R	17.7	2.5	.48	14	24
	L	18.7	2.2	.43	14	24
35–39	R	17.9	2.4	.48	15	26
	L	19.4	3.5	.70	14	28
40–44	R	17.7	2.2	.43	14	22
	L	18.9	2.0	.39	16	24
45–49	R	18.8	2.3	.43	15	24
	L	20.4	2.9	.55	15	27
50–54	R	19.2	1.8	.36	15	22
	L	20.7	2.3	.46	16	25
55–59	R	19.2	2.6	.56	14	25
	L	21.0	3.2	.70	17	27
60–64	R	20.3	2.6	.54	15	25
	L	21.0	2.5	.51	18	27
65–69	R	20.7	2.9	.55	15	29
	L	22.9	3.5	.67	18	30
70–74	R	22.0	3.3	.65	17	30
	L	23.8	3.9	.77	16	33
75+	R	22.9	4.0	.80	17	35
	L	26.4	4.8	.96	19	37
All Male	R	19.0	3.2	.18	13	35
Subjects	L	20.6	3.9	.22	13	37

performance (highest score). Thus, it was not surprising that there was a high correlation between the Nine Hole Peg Test and age (males: right hand r = .62, left hand r = .65; females: right hand r = .61, left hand r = .63).

When the scores of all male subjects and all female subjects were compared using the data from Tables 3 and 4, it was clear that the average female scored slightly better than the average male. This can be graphically seen in Figure 3, which also demonstrates a relatively normal curve in the distribution of scores on the Nine Hole Peg Test.

When the scores of right-hand dominant and left-hand dominant subjects were compared, there was little functional difference between their mean scores. As would be expected, for male and female right-hand dominant subjects, their right-hand mean scores were 1 to 2 seconds better than their left-hand mean scores. For male left-hand dominant subjects, their left-hand mean scores were less than 1 second better than their right-hand mean scores. In contrast, female left-hand dominant subjects scored better with their right hands than with their left hands. Due to these mixed results with left-hand dominant subjects, the relatively small differences between their mean scores, and the fact that left-hand dominant subjects comprised only 7% of the sample, the normative data in

Table 4
Average Performance of Normal Females
on the Nine Hole Peg Test (time in seconds)

Age	Hand	Mean	SD	SE	Low	High
20–24	R	15.8	2.1	.41	12	22
	L	17.2	2.4	.47	14	26
25–29	R	15.8	2.2	.43	13	23
	L	17.2	2.1	.40	15	25
30–34	R	16.3	1.9	.36	13	20
	L	17.8	2.0	.40	15	22
35–39	R	16.4	1.6	.32	14	20
	L	17.3	2.0	.40	15	21
40–44	R	16.8	2.1	.37	14	23
	L	18.6	2.8	.51	15	24
45–49	R	17.3	2.0	.39	13	23
	L	18.4	1.9	.38	16	24
50–54	R	18.0	2.5	.50	14	24
	L	20.1	3.0	.60	16	26
55–59	R	17.8	2.6	.52	14	26
	L	19.4	2.3	.47	16	24
60–64	R	18.4	2.0	.39	15	22
	L	20.6	2.2	.44	17	25
65–69	R	19.5	2.3	.44	16	25
	L	21.4	2.7	.51	17	26
70–74	R	20.2	2.7	.51	15	26
	L	22.0	2.7	.51	18	27
75+	R	21.5	2.9	.58	17	31
	L	24.6	4.3	.85	18	35
All Female	R	17.9	2.8	.16	12	31
Subjects	L	19.6	3.4	.19	14	35

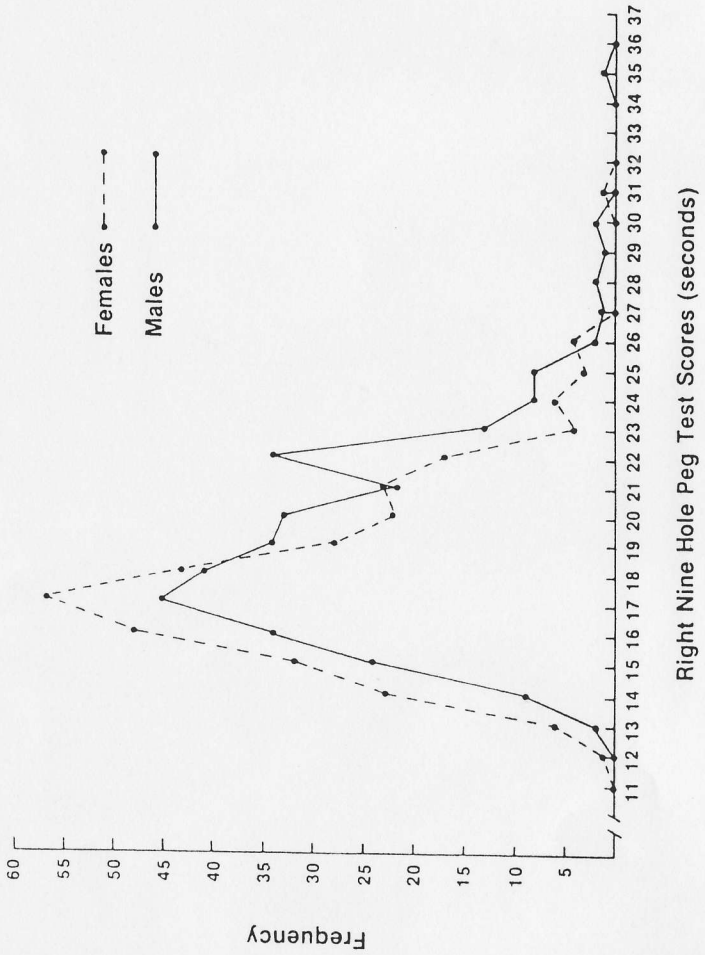

Figure 3 Frequency polygons for female and male, right Nine Hole Peg Test scores

Tables 3 and 4 are the combination of both right- and left-hand dominant subjects.

DISCUSSION

Reliability and Validity Study

The very high interrater reliability demonstrated that two independent raters scored the test in nearly the exact same way. The moderate to high test-retest reliability scores were lower than desirable for a test of finger dexterity. The Purdue Pegboard, a similar test, has reported higher reliability (r = .60 to .79) for one trial testing. One possible explanation is that the sample tested in this study was a very homogeneous group of normal subjects (minimal variance in scores). Since the average test scores were relatively low, a small change in scores could have affected the reliability. Test-retest reliability might be improved by requiring two or three trials to obtain a larger sample of the subject's performance. Many tests of dexterity, such as the Purdue Pegboard and the Minnesota Rate of Manipulation Test, suggest multiple trials to improve reliability. In addition, the square container designed for the pegs may have affected scores. Some subjects had difficulty picking up pegs that were in the corners, which might not be a problem with a round container. Another consideration is that the Nine Hole Peg Test has been recommended as a clinical test for physically handicapped subjects and not for normal subjects. Since handicapped subjects tend to be a more heterogeneous group (wider variance in scores), test-retest reliability might be higher with that sample. The Jebsen Hand Function Test, which also has low scores and was designed for physically handicapped subjects, has test-retest reliability data on subjects with stable hand disorders only. The implication is that reliability data on normal subjects is less important since the test was recommended for handicapped subjects only.

Although a practice trial was added to the standardized procedures of the Nine Hole Peg Test, a significant practice effect remained. This means that an improvement in a subject's retest score could simply be due to the practice obtained in the initial testing. Since some therapists also use the test as a method of treatment, the retest scores would become even more influenced by the practice effect. It is speculated that a three-trial sample, as suggested above to improve test-retest reliability, might decrease the practice effect. Further research is needed to address these issues.

The moderate to high inverse relationship between the Nine Hole Peg Test and the Purdue Pegboard indicated that the test measured similar

but not equivalent aspects of finger dexterity. This would imply that both tests might be useful in evaluating finger dexterity and that neither could completely substitute for the other.

Normative Study

The normative data in this study support conclusions of previous studies. That is, females have slightly better dexterity than males (Mathiowetz, Volland, Kashman, & Weber, in press; Rushmore, 1942), right-hand scores are better than left-hand scores, and for adults dexterity gradually decreases with age (Kellor et al., 1971; Mathiowetz, Volland, Kashman, & Weber, in press).

Future research regarding the Nine Hole Peg Test should address the following questions:

1. Would two or three trials of the test improve test-retest reliability and decrease the practice effect?
2. Would test-retest reliability improve with a sample of physically handicapped subjects?
3. Would a shallow round container improve test-retest reliability?
4. Does the Nine Hole Peg Test distinguish between normal subjects and subjects with poor finger dexterity?
5. If the standardized procedures of the test need to be changed to improve the reliability of the test, does the normative data collected in this study remain accurate?

An additional question of interest to occupational therapists would concern the relationship between tests of dexterity (e.g., Nine Hole Peg Test, Box and Block Test, etc.) to tests of hand function (e.g., Jebsen) or to performance of functional activity. Although relationships might be presumed, these have never been well documented.

Due to the many unresolved questions regarding the Nine Hole Peg Test, it should be used with caution. It should not be used to test normal subjects (i.e., evaluating normal individuals for job placement). There are better dexterity tests available (e.g., Purdue Pegboard, Minnesota Rate of Manipulation Test, etc.) that have been designed for this purpose. The test also should not be used to research the effectiveness of treatment to improve poor finger dexterity. The test might be cautiously used as a quick screening tool for finger dexterity. If a deficit were found, additional testing would be indicated to confirm the deficit and to evaluate the effectiveness of treatment over time.

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REFERENCES

Agnew, P. J., & Mass, F. (1982). Hand function related to age and sex. *Archives of Physical Medicine and Rehabilitation, 63*, 269–271.

Gardner, R. A., & Broman, M. (1979). The Purdue Pegboard: Normative data on 1334 school children. *Journal of Clinical Child Psychology, 7*, 156–162.

Jack, S., & Ries, P. (1981). Current estimate from national health interview survey in the United States. *Vital and Health Statistics*, Series 10-136. (DHHS Publication No. 81-1564). Washington, DC: Public Health Service.

Jebsen, R. H., Taylor, N., Trieschmann, R. B., Trotter, M. J., & Howard, L. A. (1969). An objective and standardized test of hand function. *Archives of Physical Medicine and Rehabilitation, 50*, 311–319.

Kellor, M., Frost, J., Silberberg, N., Iversen, I., & Cummings, R. (1971). Hand strength and dexterity. *American Journal of Occupational Therapy, 25*, 77–83.

Mathiowetz, V., Kashman, N., Volland, G., Weber, K., Dowe, M., & Rogers, S. L. (in press). Grip and pinch strength: Normative data for adults. *Archives of Physical Medicine and Rehabilitation*.

Mathiowetz, V., Volland, G., Kashman, N., & Weber, K. (in press). Adult norms for the Box and Block Test of manual dexterity. *American Journal of Occupational Therapy*.