

Normative Data of the Upper Extremity Performance Test for the Elderly (TEMPA) for Korean Older Adults and Characteristics of Hand Function and Strength

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Abstract

Objective : This study aimed to identify the characteristics of hand function according to age and sex in older adults.

Methods : This study included 103 healthy adults aged ≥ 60 years. The Korean version of TEMPA was used to assess hand function and a Jamar dynamometer and pinch gauge were used to assess hand and pinch strength in all participants.

Results : The results of hand function assessment showed that speed of task execution (mean = 121.32 s, SD = 18.07 s in subjects aged 60–69; mean = 144.97 s, SD = 28.43 s in subjects aged 70–79; and mean = 160.93 s, SD = 38.33 s in subjects aged ≥ 80 , $p < .001$) and fine movement (mean score = $-.14$, SD = $.40$ in subjects aged 60–69; mean score = $-.63$, SD = 1.07 in subjects aged 70–79; and mean score = $-.57$, SD = $.65$ in subjects aged ≥ 80 , $p = .01$) decreased significantly with age. The male group showed better speed of task execution (mean = 133.54, SD = 22.83 in males vs. mean = 150.55, SD = 39.89 in females, $p < .01$) and fine movement (mean score = $-.16$, SD = $.37$ in males vs. mean score = $-.46$, SD = $.58$ in females, $p < .01$) than the female group. Hand strength also decreased significantly with age ($p < .05$, to $p < .001$).

Conclusion : Occupational therapists should be aware of the decline in hand function (especially speed of task execution and fine movement) and strength in older adults, as well as the need to provide interventions to treat this decline.

Key words : Elderly, Hand function, Hand strength, TEMPA

I. Introduction

A well-functioning hand is essential for everyday activities and is associated with quality of life (Regardt, 2014). Moreover, hand function is correlated with cognitive function and the ability to live independently (Incel, Sezgin, As, Cimen, & Sahin, 2009; Regardt, 2014). Thus, it is important to maintain hand functionality as long as possible for a healthier life. However, as society ages, an increasing number of older adults have difficulty using their upper extremities, not only due to geriatric disease or disorders such as stroke, rheumatoid arthritis, or multiple sclerosis but also due to normal aging (Carmeli, Patish, & Coleman, 2003; Sorock, et al., 2001). To optimize independent healthy living in older adults, occupational therapists need to understand the characteristics of hand function associated with natural aging according to age and sex.

The UpperExtremity Performance Test for the Elderly (Test Evaluant les Membres Superieurs des Personnes Agees; TEMPA) is used to evaluate hand function in older adults. TEMPA consists of 9 tasks that were selected through analysis of activities of daily living, TEMPA uses quantitative (speed of execution) and qualitative (functional rating and task analysis) methods to assess hand function (Desrosiers, Hebert, Dutil, & Bravo, 1993). These features provide precise hand function measurements and assessment of complex hand functions during performance of daily activities through simultaneous use of quantitative and qualitative methods (Desrosiers et al., 1993). Use of both quantitative data, such as speed, and

qualitative data, such as quality of movement, enables better understanding of hand function compared to use of either parameter alone (Jebsen, Taylor, Trieschmann, Trotter, & Howard, 1969; Lemmens, Timmermans, Janssen-Potten, Smeets, & Seelen, 2012). Therefore, TEMPA enables therapists to simultaneously provide both overall and comprehensive assessment of hand function in older adults. Additionally, reliable and validated maximum isometric grip and pinch strength tests are used to evaluate hand function in older adults (Hamilton, Balnave, & Adams 1994; Mathiowetz, Weber, Volland, & Kashman, 1984). The tests are widely used in evaluation of hand function not only because they are easy, fast, and inexpensive measurement tools but also because they sensitively reflect neurological and musculoskeletal status (Bohannon, 2015; Jones, 1989). Thus, hand and pinch strength tests can sensitively detect differences in hand function between age groups in older adults.

Therefore, the purpose of the study was to investigate the characteristics of hand function according to age and sex in older adults using TEMPA and hand and pinch strength tests.

II. Method

1. Participants

The study included 103 adults aged ≥ 60 years (Table 1). Inclusion criteria were as follows: (1) absence of neurological or musculoskeletal diseases that can affect hand function, (2) absence of a visual problem, (3) absence of

cognitive impairment (Mini-Mental State Examination score >24), (4) ability to follow instructions, and (5) ability to understand the purpose of the study and agree to participate. After a brief interview, only participants who met the inclusion criteria were informed about the purpose and process of the assessment. The participants were community-dwelling older adults and data were collected through continuous sampling. This study was approved by the institutional review board (IRB) at Yonsei University and written informed consent was obtained from all participants.

2. Measurements

1) Upper Extremity Performance Test for the Elderly (Test Evaluant les Membres Superieurs des Personnes Agees; TEMPA) Korean version

TEMPA was developed by Desrosiers et al. (1993) to assess hand function in older adults and was recently introduced in Korea (Lee, 2015). TEMPA includes a total of 9 tasks (4 unilateral, 5 bilateral) that were selected through analysis of activities of daily living. TEMPA measures hand

function using 3 subscores: (1) speed of execution, (2) functional rating, and (3) task analysis. Speed of execution measures duration required for task completion. A maximum of 120 s is provided to complete each task. Functional rating measures autonomy in performing the tasks and uses a 4-point scale (0 to 3 points). Task analysis also uses a 4-point scale (0 to 3 points), and identifies and quantifies difficulties encountered while performing the tasks. Higher functional rating and task analysis score indicate the patient performs at a higher functional level. The test-retest reliability of the TEMPA Korean version was .71–1.0, and the Intraclass Correlation Coefficient (ICC) was .79–1.0 (Lee, 2015).

2) Jamar dynamometer and pinch gauge

An adjustable-handle Jamar dynamometer was used to accurately measure grip strength and palmar grasp strength (Bellace, Healy, Besser, Byron, & Hohman, 2000). For standardization, the dynamometer was set at the second handle position for all participants. A pinch gauge was

Table 1. General Participants Information

(N=103)

Variables		N (%)
Sex	Male	51(49.5)
	Female	52(50.5)
Age (years)	60–69	36(14.9)
	70–79	32(13.3)
	≥80	35(14.5)
Dominant hand	Right	100(97.1)
Education	No formal education	19(18.4)
	Elementary school	37(35.9)
	Middle school	19(18.4)
	High school	16(15.6)
	More than college degree	12(11.7)

used to measure lateral, tripod, and fingertip pinch strength. For lateral pinch, the gauge was held between the thumb pad and radial side of the index finger. For tripod pinch, the gauge was held between the thumb and volar pads of the index and middle fingers. A tip pinch was performed between the thumb and index fingers. Participants were assessed in a seated position, with the shoulder adducted and neutrally rotated, the elbow flexed at 90°, the forearm positioned neutrally and resting on a support, and the wrist extended at 0–30°, with ulnar deviation at 0–15°.

3. Procedures

Participants performed the TEMPA Korean version and the hand and pinch strength tests in consecutive order. Palmar grasp, lateral pinch, tripod pinch, and tip pinch strength were measured 3 times repeatedly, with a 60-s pause for recovery between measurements. The final outcome was presented as a mean score. To compare the outcomes by age, the participants were allocated into 3 groups (60–69 years, 70–79 years, and ≥80 years); participants were also grouped according to sex. All measurements were performed by the same examiner.

4. Analysis

Descriptive statistics were used to analyze general patient information. The independent t-test and one-way analysis of variance were used to compare the results for speed of execution according to age group and sex; the Scheffe test was used for post-hoc analysis. The

chi-square test was used to compare the results for functional rating and task analysis. We used SPSS (Version 21.0) to analyze the outcomes.

III. Results

1. Characteristics of hand function according to age group

The overall speed of execution decreased with age ($p < .001$). Comparable results were found for each task; older age groups required more time to complete each task than younger age groups ($p < .001$). The functional rating identified differences between age groups; however, the differences were not statistically significant. On the other hand, the results of task analysis showed statistically significant differences in fine movement and overall score between age groups ($p < .05$) (Table 2).

2. Characteristics of hand function according to sex

The results showed that overall speed of execution was greater in males than in females, as well as for assigned tasks such as ‘pick-up and move a jar’, ‘write and affix a postage stamp’, and ‘shuffle and deal cards’ ($p < .01$). The results for functional rating did not show any difference between sexes. In task analysis, male scores for overall and fine movement were higher than female scores ($p < .01$; Table 3).

Table 2. Comparison of TEMPA results among age groups

(N=103)

Tasks		Speed of execution (s)			<i>p</i>	Functional rating (score)			<i>p</i>
		Age 60–69 years (n=36)	Age 70–79 years (n=32)	Age ≥80 years (n=35)		Age 60–69 years (n=36)	Age 70–79 years (n=32)	Age ≥80 years (n=35)	
		M(SD)	M(SD)	M(SD)		M(SD)	M(SD)	M(SD)	
Pick up and move a jar	Right	1.12 (0.33) ^a	1.33 (0.30)	1.42 (0.44) ^a	.00**	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	1.0
	Left	1.15 (0.33) ^{a,b}	1.40 (0.30) ^a	1.51 (0.49) ^b	.00***	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	1.0
Open a jar and take a spoonful of coffee		9.34 (2.28) ^a	11.03 (2.72)	11.74 (3.73) ^a	.00**	0.00 (0.00)	0.00 (0.00)	-0.03 (0.17)	.65
Pour water from a pitcher into a glass	Right	10.47 (1.41) ^a	11.25 (2.11)	11.97 (3.34) ^a	.00*	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	1.0
	Left	9.66 (1.84) ^{a,b}	11.28 (2.23) ^a	11.34 (2.51) ^b	.00**	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	1.0
Open a lock and take the top off a pillbox		13.66 (2.61) ^{a,b}	16.72 (4.49) ^a	18.07 (4.87) ^b	.00***	-0.03 (0.17)	-0.06 (0.25)	0.00 (0.00)	.31
Write and affix a postage stamp		15.79 (4.46) ^{a,b}	21.97 (9.32) ^a	25.36 (10.03) ^b	.00***	0.00 (0.00)	-0.09 (0.30)	-0.06 (0.24)	.16
Put a scarf around one's neck		8.59 (3.66) ^a	9.29 (2.61)	12.65 (9.01) ^a	.00**	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	1.0
Shuffle and deal cards		17.93 (4.30) ^{a,b}	21.44 (4.11) ^{a,c}	24.86 (7.22) ^{b,c}	.00***	-0.03 (0.17)	-0.06 (0.25)	-0.09 (0.28)	.60
Use coins	Right	8.37 (1.41) ^{a,b}	9.41 (1.75) ^a	10.28 (1.89) ^b	.00***	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	1.0
	Left	8.44 (1.39) ^{a,b}	9.68 (1.66) ^a	10.15 (2.12) ^b	.00***	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	1.0
Pick up and move small objects	Right	8.31 (1.50) ^a	10.16 (4.06)	10.78 (3.21) ^a	.00**	0.00 (0.00)	-0.06 (0.25)	0.00 (0.00)	.09
	Left	8.48 (1.79) ^a	10.03 (3.32)	10.80 (3.06) ^a	.00**	-0.03 (0.17)	-0.03 (0.18)	0.00 (0.00)	.76
Overall		121.32 (18.07) ^{a,b}	144.97 (28.43) ^a	160.93 (38.33) ^b	.00***	-0.08 (0.37)	-0.34 (0.90)	-0.17 (0.51)	.29
Task analysis (score)									
Tasks	Age 60–69 years (n=36)		Age 70–79 years (n=32)		Age ≥80 years (n=35)		<i>p</i>		
	M(SD)		M(SD)		M(SD)				
Range of movement	0.00 (0.00)		0.00 (0.00)		0.00 (0.00)		1.0		
Strength	0.00 (0.00)		0.00 (0.00)		0.00 (0.00)		1.0		
Control of gross movement	0.00 (0.00)		0.00 (0.00)		0.00 (0.00)		1.0		
Prehensions patterns	-0.06 (0.23)		-0.22 (0.55)		-0.17 (0.45)		.53		
Fine movement	-0.14 (0.35)		-0.41 (0.61)		-0.40 (0.50)		.02*		
Overall	-0.19 (0.40)		-0.63 (1.07)		-0.57 (0.65)		.01*		

p*<.05, *p*<.01, ****p*<.001, a: age 60–69 years, b: age 70–79 years, c: age ≥80 years. Superscript letters (a,b,c) denote results of the Scheffe multiple comparison across groups,

Table 3. Comparison of TEMPA Results Between Sexes

(N=103)

Tasks		Speed of execution (s)			Functional rating (score)		
		Male (n=51)	Female (n=52)	p	Male (n=51)	Female (n=52)	p
		M(SD)	M(SD)		M(SD)	M(SD)	
Pick up and move a jar	Right	1.15 (0.29)	1.42 (0.41)	.00***	0.00 (0.00)	0.00 (0.00)	1.0
	Left	1.20 (0.31)	1.49 (0.45)	.00***	0.00 (0.00)	0.00 (0.00)	1.0
Open a jar and take a spoonful of coffee		10.50 (2.31)	10.86 (3.77)	.55	-0.02 (0.14)	0.00 (0.00)	.50
Pour water from a pitcher into a glass	Right	10.91 (2.03)	11.53 (2.84)	.20	0.00 (0.00)	0.00 (0.00)	1.0
	Left	10.58 (1.97)	10.88 (2.63)	.51	0.00 (0.00)	0.00 (0.00)	1.0
Open a lock and take the top off a pillbox		15.26 (2.91)	16.94 (5.49)	.06	0.00 (0.00)	-0.06 (0.24)	.24
Write and affix a postage stamp		17.63 (6.16)	24.23 (10.35)	.00***	-0.02 (0.14)	-0.08 (0.27)	.36
Put a scarf around one's neck		9.14 (2.40)	11.22 (8.13)	.08	0.00 (0.00)	0.00 (0.00)	1.0
Shuffle and deal cards		19.80 (4.83)	22.92 (6.83)	.01**	-0.02 (0.14)	-0.10 (0.30)	.21
Use coins	Right	9.37 (1.75)	9.31 (1.97)	.87	0.00 (0.00)	0.00 (0.00)	1.0
	Left	9.30 (1.56)	9.51 (2.16)	.58	0.00 (0.00)	0.00 (0.00)	1.0
Pick up and move small objects	Right	9.40 (1.77)	10.04 (4.18)	.31	-0.02 (0.14)	-0.02 (0.14)	1.0
	Left	9.29 (2.21)	10.20 (3.45)	.12	0.00 (0.00)	-0.04 (0.19)	.50
Overall		133.54 (22.83)	150.55 (39.89)	.01**	-0.10 (0.36)	-0.29 (0.80)	.73
Task analysis (score)							
Items	Male (n=51)		Female (n=52)		p		
	M(SD)		M(SD)				
Range of movement		0.00 (0.00)		0.00 (0.00)		1.0	
Strength		0.00 (0.00)		0.00 (0.00)		1.0	
Control of gross movement		0.00 (0.00)		0.00 (0.00)		1.0	
Prehensions patterns		-0.06 (0.24)		-0.23 (0.55)		.10	
Fine movement		-0.16 (0.37)		-0.46 (0.58)		.01**	
Overall		-0.22 (0.46)		-0.69 (0.92)		.00**	

p<.01, *p<.001

Table 4. Comparison of hand strength (kg) among age groups and between sexes

(N=103)

Items		Male			<i>p</i>	Female			<i>p</i>
		Age 60–69 years (n=21)	Age 70–79 years (n=15)	Age ≥80 years (n=15)		Age 60–69 years (n=15)	Age 70–79 years (n=17)	Age ≥80 years (n=20)	
		M(<i>SD</i>)	M(<i>SD</i>)	M(<i>SD</i>)		M(<i>SD</i>)	M(<i>SD</i>)	M(<i>SD</i>)	
Palmar grasp	Right	36.86 (5.40) ^{a,b}	28.98 (6.49) ^a	29.47 (7.35) ^b	.00**	21.31 (4.82) ^a	17.65 (4.30) ^b	13.43 (4.50) ^{a,b}	.00***
	Left	35.51 (6.63) ^{a,b}	27.13 (5.14) ^a	28.40 (8.40) ^b	.00**	21.04 (5.04) ^a	17.22 (4.31) ^b	12.78 (4.78) ^{a,b}	.00***
Lateral pinch	Right	21.21 (2.20) ^a	18.98 (2.57)	17.76 (3.89) ^a	.01**	14.67 (2.76) ^a	14.51 (2.18) ^b	11.63 (2.75) ^{a,b}	.00**
	Left	20.73 (2.83) ^{a,b}	17.27 (3.60) ^a	16.69 (4.28) ^b	.00**	13.76 (2.73) ^a	12.75 (2.20) ^b	9.63 (2.75) ^{a,b}	.00***
Tripod pinch	Right	17.62 (2.58) ^a	14.40 (3.09) ^a	15.58 (3.88)	.01**	12.51 (2.71) ^a	10.82 (2.54)	9.53 (2.59) ^a	.01**
	Left	17.65 (3.08) ^{a,b}	13.98 (3.07) ^a	13.98 (3.76) ^b	.00**	12.42 (2.65) ^a	10.31 (2.01)	7.98 (2.41) ^a	.00***
Tip pinch	Right	14.05 (2.90) ^a	10.91 (2.70) ^a	12.00 (2.94)	.02*	11.13 (2.56) ^a	8.92 (2.08)	7.65 (2.42) ^a	.00**
	Left	14.40 (3.45) ^a	10.82 (2.12) ^a	12.38 (3.62)	.01**	10.62 (2.44) ^a	8.61 (2.09)	7.00 (2.40) ^a	.00***

p<.01, *p<.001, a: age 60–69 years, b: age 70–79 years, c: age ≥80 years. Superscript letters(a,b,c)denote results of the Scheffe multiple comparison across groups

3. Hand and pinch strength

Hand and pinch strength generally decrease with aging. Those aged 60–69 showed greater hand and pinch strength than those aged 70–79 and ≥80; similarly, those aged 70–79 showed greater strength than those aged ≥80. Detailed results are shown in Table 4.

IV. Discussion

The purpose of the study was to identify characteristics and changes in hand function

according to age and sex in older adults. The results showed that agility, qualitative movement, and hand and pinch strength decreased with age; the findings were consistent with those of previous studies(Carmeli et al., 2003; Ranganathan, Siemionow, Sahgal, & Yue, 2001). The decrease in speed of execution and qualitative movement (especially in fine movement) may be due to reduced sensation and central nervous system function. Sensory information is necessary in order to pick up, hold, and manipulate objects with the fingers and hand (Johansson, 1996). As the sense of touch and sensation decreases with age, older adults may have difficulty with fine muscle control (Cole & Rotella, 2001). Moreover, degeneration

of the cerebral motor cortex, cerebellum, and basal ganglia increases with age (Calne, Eisen, & Meneilly, 1991), and may have had a negative effect on fine muscle control. Similarly, neurological degeneration results in reduction in the number of synaptic nerves that connect to the hand muscles, resulting in decreased hand and finger strength (Chae & Lee, 1997; Hesselmann et al., 2001). Thus, neurological degeneration may lead to a decline in hand function and hand and finger strength in older adults.

Hand function was better in males than in females among older adults. The results confirm that agility and qualitative movement decline faster in females than in males (Ranganathan et al., 2001). Females may show faster decline in fine movements because more females have age-related disorders such as osteoarthritis or rheumatoid arthritis, which affect fine movement. However, either these degenerative disorders were not detected in a brief interview or the participants did not recognize or report these disorders (Anderson, & Loeser, 2010; Werle et al., 2009).

The general results for hand and pinch strength were found to decrease with age, consistent with other studies. While there were differences in specific results in comparisons with normative data for hand strength in the Korean population (Kim, Jeon, Kim, Jeong, & Koo, 2018), most differences were minor (<10%). However, the differences between the groups were greater for the left hand in males aged 70–79 (10.8%) and for both right and left hands in males aged ≥ 80 (11.1% and 10.2%, respectively). The differences

may be due to non-random sampling and the small sample size. Due to non-probability sampling bias, the study could not control factors such as education level and occupation, which can affect hand function (LaCroix, Guralnik, Berkman, Wallace, & Satterfield, 1993; Russo et al., 2006).

Nonetheless, hand agility and fine movement generally decline faster in females than in males among older adults; moreover, hand agility, fine movement, and strength decline with age in both sexes. Therefore, occupational therapists need to provide interventions that can prevent decline or restore deficiencies in hand function and strength. These interventions can include education and therapeutic exercises. Joint protection techniques can be taught in an educational program. Use of the small joints and muscles of the hand can aggravate the symptoms or magnify the adverse effects of degenerative disorders (e.g., osteoarthritis or rheumatoid arthritis) in older adults. Through joint protection techniques, therefore, older adults can reduce the prevalence or minimize the adverse effects of degenerative disorders that affect hand function (Stamm et al., 2002). In addition, a skilled finger movement exercise (e.g., holding 2 baoding balls in the hand and rotating them smoothly or squeezing a rubber ball) can be used for therapeutic exercise to improve pinch strength, speed of movement, and motor neuron excitability (Ranganathan, Siemionow, Sahgal, Liu, & Yue, 2001). Such interventions aim to optimize independent healthy living and increase quality of life in older adults (Incel et al., 2009; Regardt, 2014)

V. Conclusion

This study identified the characteristics of hand function in older adults. As hand agility, fine movement, and hand and pinch strength decline, occupational therapists need to provide interventions to prevent impairment and restore and improve hand function in older adults, with special focus on fine movement, which shows the earliest decline.

Declaration of Interest

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한국 노인의 TEMPA 표준치, 손기능과 근력에 관한 연구

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목적 : 본 연구의 목적은 Upper extremity performance test for elderly (TEMPA)의 한국 노인 표준치를 제시하고, 수집된 자료를 바탕으로 한국 노인의 연령별, 성별 손 기능의 특성과 근력의 차이를 알아보는 것이다.

연구방법 : 연구에 참여한 대상자는 60세 이상의 손 기능에 장애가 없는 노인 103명이었다. 손 기능의 특성을 알아보기 위하여 모든 대상자에게 TEMPA 평가를 시행하였고, Jarmar dynamometer, pinch gauge를 사용하여 손과 손가락 근력을 평가하였다.

결과 : 나이가 증가함에 따라 수행 속도와 소 근육의 움직임의 질이 유의미하게 감소하였다. 남성 노인의 수행 속도와 소 근육 움직임의 질이 여성 노인보다 더 높게 유지되었다. 노인의 손과 손가락의 근력 또한 연령이 증가함에 따라 유의미하게 감소하였다.

결론 : 작업치료사는 노인의 손 기능과 근력 감소에 대한 관심을 가지고 그 기능 수준을 유지하기 위한 중재를 제공하는 것이 필요할 것이다. 본 연구를 통해 TEMPA의 한국 노인 표준치가 확립되었다. 이 자료가 임상적 평가 및 근거 기반의 연구에 있어 유용하게 쓰이기를 기대한다.

주제어 : 노인, 손 기능, 손 근력, TEMPA