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RESEARCH

The effect of hand morphometric measurements on the manual dexterity in students of Vocational School of Health Services

Sağlık Hizmetleri Meslek Yüksekokulu öğrencilerinde el morfometrik ölçümlerinin el becerisine etkisi

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Abstract

Purpose: This paper aimed to evaluate the manual dexterity tests and hand morphometry, and to research whether the dexterity tests and hand lengths were affected by gender and body mass index (BMI) or not.

Materials and Methods: This study was carried out on 114 adult subjects aged between 18 and 25 years (37 males and 77 females). Demographic characteristics including gender, age, dominant hand, height, weight, and body mass index (BMI) of all subjects were recorded. Additionally, hand morphometric measurements and manual dexterity tests called as O'Connor Finger Dexterity Test and Purdue Pegboard Test were applied.

Results: Some values such as the hand length (right and left), palmar length (right and left), dominant and non-dominant hand finger, and O'Connor Finger Dexterity Test-Left side showed significant differences between genders. Additionally, O'Connor Finger Dexterity Test scores for both sides were lower in males than in females. Purdue Pegboard-Right, and Purdue Pegboard-Left, Purdue Pegboard-Both Hands, Purdue Pegboard total were higher in males, whereas Purdue Pegboard (Assembly) was higher in females than in males. However, Purdue Pegboard measurement scores did not show a significant difference between genders.

Conclusion: Hand morphometric measurements and manual dexterity tests showed some changes in terms of gender and BMI. Additionally, the data obtained can provide crucial information for therapists and clinicians about hand rehabilitation.

Keywords: Manual dexterity test; o'connor finger dexterity test; purdue pegboard test

Öz

Amaç: Bu çalışma, el becerisi testlerini ve el morfometrisini değerlendirmek ve el becerisi testleri ile el uzunluklarının cinsiyet ve beden kitle indeksinden (BKİ) etkilenip etkilenmediğini araştırmaktır.

Gereç ve Yöntem: Bu çalışma, 18-25 yaş arası 114 sağlıklı yetişkin (37 erkek ve 77 kadın, 18-25 yaş arası) birey üzerinde yapılmıştır. Çalışmaya katılan bireylerin cinsiyet, yaş, dominant el, boy uzunluğu ve vücut ağırlığı parametrelerini içeren demografik özellikleri ve BKİ kaydedildi. Ayrıca, el morfometrik ölçümleri ile el beceri testleri olarak adlandırılan O'Connor Parmak Beceri Testi ve Purdue Pegboard Testi uygulandı.

Bulgular: El uzunluğu (sağ ve sol), avuç içi uzunluğu (sağ ve sol), dominant ve dominant olmayan el parmağı uzunluğu ve O'Connor Parmak Beceri Testi (sol taraf) cinsiyete göre anlamlı farklılık gösterdi. Ayrıca, O'Connor Parmak Beceri Testi her iki taraf için de erkeklerde kızlara göre daha düşüktü. Purdue Pegboard (assembli) toplamı kadınlarda erkeklerden daha yüksek bulunmasına rağmen, Purdue Pegboard (sağ) ve Purdue Pegboard (sol), Purdue Pegboard (iki el), Purdue Pegboard toplamı erkeklerde daha yüksekti. Fakat, Purdue Pegboard ölçüm puanları cinsiyetler arasında anlamlı farklılık göstermedi.

Sonuç: El morfometrik ölçümleri ve el becerisi testleri cinsiyet ve BKİ açısından bazı değişiklikler gösterdi. Ayrıca elde edilen veriler terapistlere ve klinisyenlere el rehabilitasyonu konusunda önemli bilgiler sağlayabilir.

Anahtar kelimeler: El becerisi testleri; o'connor parmak beceri testi; purdue pegboard testi

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INTRODUCTION

The human hand has a complicated structure. Multiple complex functions like grip, touch, and hold can be performed via hand. It is known that hand functions are affected by many factors such as muscle strength, sensory function, skill, motivation, age, gender, and dominant hand[1]. Dexterity, which is defined as handling objects with fine skill, and voluntary movements during a specific work, is typically a supplementary and essential part of a complete assessment of the hand[2]. In the determination of the neuromotor function of the hand, dexterity is one of the most critical assessment methods. It includes the integration of motor and sensorial functions. Furthermore, dexterity is a significant marker of independence in daily living activities. Several factors such as age, gender, and hand dominance affect dexterity which is one of the hand assessments[2-5]. It is accepted that one of the most important signs of independence in daily living activities is dexterity or manual dexterity[3]. Moreover, according to dexterity tests, the hand dexterity of females was higher than males' dexterity[6]. There are some challenges in the healthcare environment. Two of these are the effectiveness and time efficiency of treatment, which may be widely improved by coupling clinical evaluation with proper and correct measurement tools. For patients with hand disorders to undergo a holistic assessment, the assessment must include performance areas in the context of activities of daily living. While evaluating hand functions, besides muscle strength, range of motion, and sensory evaluations should not forget to include manual dexterity tests[7]. Although there are various grasping patterns such as tripod, precision, lateral precision, power, spherical, and extension grip styles; hand evaluation methods may be used for several reasons such as identification and standardization of grasping patterns. The identification and evaluation of hand functions is extremely crucial for the assessment of treatment of rehabilitation[8-10]. Hand morphometric measurements are crucial for the glove industry. Gloves are used for various reasons such as industry work, surgery, or fight sector, etc. To be sensitivity during the usage of gloves, anthropometric measurements of the hand should be performed very carefully. Moreover, hand dexterity is a crucial factor that is influenced by glove quality[11].

We hypothesized that the dexterity tests and BMI affect the hand morphometric measurements, and the values showed a significant difference between genders. Hand is a very critical region for the continuation of daily life activities. The frequent occurrence of hand injuries has further increased the importance of this region. While hand dexterity tests are used in the evaluation of hand functions, they also make a great contribution to the evaluation of the effectiveness of the rehabilitation program. In addition to presenting reference values for healthy young adults in the literature, our study also showed the effects of hand dexterity tests, hand morphometry, and body mass index on each other. Therefore, we aimed to evaluate the dexterity tests and hand morphometry. Also, we researched whether the dexterity tests and lengths were affected by gender and body mass index (BMI) or not.

MATERIALS AND METHODS

Study design and sample

This study was carried out on 114 adult subjects (37 males and 77 females, aged between 18 and 25 years). Firstly, 127 subjects participated in this study. Individuals not meeting the study criteria were reported as five subjects due to upper extremity problems. Four subjects refused to attend this study. Four subjects who could not complete this study were excluded from the study. Both oral and written statements were taken from these subjects. The study protocol was approved by the Ethics Committee of Çukurova University, with Decision No: 2021/117-73.

This research was performed in the Department of Therapy and Rehabilitation of Abdi Sütcü Vocational School of Health services. The study was conducted over 2 years between January 2021 and 2023. Measurements were applied by two researchers (EİI and SP). All measurements were applied twice to participants and the best measurement value was recorded. Moreover, all tests were performed at the same time in the morning. They signed informed consent forms before the beginning of the study. Demographic characteristics including gender, age, dominant hand, height, and weight of all subjects were recorded. Also, the body mass index (BMI) was calculated according to the formula: BMI=weight (kg) /height^2 (m^2). Height measurements were performed with a stadiometer, while weight was digital bascule. Also, length measurements were made with a sliding digital caliper.

Subjects were divided into three as Group 1, BMI<18; Group 2, 18<BMI<25 and Group 3,

BMI>25. Additionally, the lengths of the hand, palmar, and tallest finger were measured for both hands.

The exclusion criteria were having a history of upper extremity surgery, or fracture within the previous 5 years, having a systemic disease that affects the upper extremity, having a low mental state, having diabetes, peripheral neuropathies, or neurologic disease which affected hand. On the other hand, the inclusion criteria were having an optimal health.

Manual Dexterity Tests

O'Connor Finger Dexterity Test (Lafayette Instrument Co., USA)

This test was used for assessment of the fast manipulation skills in picking up and placing small objects such as assembly objects. The test materials include a square board with holes 10 vertical and 10 horizontal and tiny nails[13].

Purdue Pegboard Test (Lafayette Instrument Model 32020)

The Purdue pegboard which is time-based determines the finger, and fingertip fine motor assessment. Test equipment includes a board called a pegboard, pins, collars, and washers located in the proper cups. The pegboard consists of two parallel vertical columns of holes. Each column comprises 25 holes, and there are four wells at the distal part of the board. There are pins at the extreme right and left wells and collars and washers at the middle wells. In the first three tasks, subjects place to holes as many pins as possible within 30 seconds. Firstly, the subject begins with a right hand from the top, then continues with the left hand from the top, thereafter both hand simultaneously places pins to holes. In the fourth task which is called "assembly", both hands work alternately. The task time is 60 seconds. Firstly, a pin is placed. Secondly, a washer is placed, then a collar, and thereafter a washer again. The score is given by the researcher according to the inserted pins in the allotted time. In the assembly task, all of the pieces are recorded as a score[14].

Statistical analysis

Statistical analysis was performed using the SPSS 22.0 software package (SPSS Inc, Chicago, IL). Descriptive statistics and frequency analysis were used to analyze the demographic characteristics. From these measurements, Means, standard deviations (SD), and minimum and maximum values were calculated. A Paired Samples Test and Mann-Whitney U test were applied for comparisons. The relationship between test results and hand morphometry was investigated using correlation analysis. Statistical significance was set at $p< 0.05$. The Spearman correlation analysis (r) was used to determine the strength of the relationship.

RESULTS

A hundred fourteen (114) voluntary participants (77 females, and 37 males) participated in this research. The mean age of the subjects was 20.49 years (range 18–25 years). The means of the height, weight, and BMI were 168 cm (range 140–185 cm), 62.39 kg (range 43–95 kg), and 21.96kg/m^2 (range 15.95-30.45kg/m^2). Additionally, height, weight, and BMI were higher in males than in females, and there were significant differences between genders (Table 1).

Table 1. Demographic features according to gender

	Gender	n	Mean±S.D.	Minimum	Maximum	p
Age (year)	Males	37	20.54±1.35	18	24	0.785
	Females	77	20.47±1.33	18	25	
	Total	114	20.49±1.33	18	25	
Height (cm)	Males	37	175.81±0.57	162	185	<0.001
	Females	77	164.27±0.70	140	185	
	Total	114	168.02±0.86	140	185	
Weight (kg)	Males	37	72.12±12.11	47	95	<0.001
	Females	77	57.71±10.62	43	91	
	Total	114	62.38±12.98	43	91	
BMI (Body mass index)	Males	37	23.31±3.71	16.26	30.45	0.003
	Females	77	21.31±3.44	15.95	30.45	
	Total	114	21.96±3.45	15.95	30.45	

N=Subjects's number participated in study; SD=Standard deviation; Min.=Minimum; Max.=Maximum; BMI=Body mass index

Table 2. The values of morphometric and the Dexterity test measurements according to gender

Measurements	Gender	N	Mean±SD	Min.	Max.	p Value
Hand Length-Right	Males	37	17.51±1.72	10.60	21.00	0.001
	Females	77	16.50±1.45	14.00	20.50	
	Total	114	16.83±1.61	10.60	21.00	
Hand Length-Left	Males	37	17.53±1.71	10.60	21.00	0.003
	Females	77	16.59±1.48	14.30	21.00	
	Total	114	16.89±1.61	10.60	21.00	
Palmar Length-Right	Males	37	10.51±1.28	7.50	13.50	<0.001
	Females	77	9.71±0.93	7.50	12.00	
	Total	114	9.97±1.12	7.50	13.50	
Palmar Length-Left	Males	37	10.59±1.28	8.00	13.60	<0.001
	Females	77	9.75±0.94	8.00	12.00	
	Total	114	10.02±1.13	8.00	13.60	
Dominant Hand Finger Length	Males	37	8.26±0.93	7.00	10.50	0.002
	Females	77	7.72±0.82	6.00	10.00	
	Total	114	7.89±0.89	6.00	10.50	
Non-dominant Hand Finger Length	Males	37	8.29±0.95	7.00	10.30	0.002
	Females	77	7.75±0.81	6.00	10.00	
	Total	114	7.93±0.89	6.00	10.30	
O'Connor Finger Dexterity Test Right	Males	37	7.03±2.63	2.30	10.50	0.187
	Females	77	7.62±2.01	2.00	11.23	
	Total	114	7.43±2.23	2.00	11.23	
O'Connor Finger Dexterity Test-Left	Males	37	7.23±2.44	2.44	10.50	0.034
	Females	77	8.16±2.02	2.48	11.33	
	Total	114	7.86±2.20	2.44	11.33	
Purdue Pegboard-Right	Males	37	16.70±1.94	12.00	23.00	0.421
	Females	77	16.34±2.39	11.00	23.00	
	Total	114	16.46±2.54	11.00	23.00	
Purdue Pegboard-Left	Males	37	15.84±1.79	12.00	20.00	0.075
	Females	77	15.16±1.95	11.00	20.00	
	Total	114	15.38±1.92	11.00	20.00	
Purdue Pegboard-Both Hands	Males	37	12.89±2.75	9.00	26.00	0.972
	Females	77	12.87±3.26	8.00	30.00	
	Total	114	12.88±3.09	8.00	30.00	
Purdue Pegboard (Assembly)	Males	37	8.08±1.53	6.00	11.00	0.612
	Females	77	8.23±1.49	5.00	13.00	
	Total	114	8.18±1.50	5.00	13.00	
Purdue Pegboard (Total)	Males	37	53.32±5.35	42.00	69.00	0.458
	Females	77	52.45±6.05	39.00	76.00	
	Total	114	52.74±5.83	39.00	76.00	

N=Subjects's number participated in study; SD=Standard deviation; Min.=Minimum; Max.=Maximum; p value=significant difference value

Table 3. Comparison of Left and Right Hand by Paired Samples T Test

Measurements	**Mean±SD**	**P value**	**r (Correlation)**
Hand Length-Right	16.83±1.61	0.026	0.981
Hand Length-Left	16.89±1.61		
Palmar Length-Right	9.97±1.12	0.016	0.981
Palmar Length-Left	10.02±1.13		
O'Connor Finger Dexterity Test-Right	7.43±2.23	<0.001	0.852
O'Connor Finger Dexterity Test-Left	7.86±2.20		
Purdue Pegboard Test-Right	16.46±2.54	<0.001	0.304
Purdue Pegboard Test-Left	15.38±1.92		

SD=Standard deviation; P value: Significance level; r: Correlation coefficient

Table 4. The values of morphometric and the Dexterity test measurements according to BMI

Measurements	BMI Class	N	Mean±SD	Min.	Max.	P
Hand Length-Right	1	15	16.44±1.60	14.00	20.40	0.313
	2	77	16.99±1.65	10.60	21.00	
	3	22	16.54±1.42	14.00	20.50	
	Total	114	16.83±1.61	10.60	21.00	
Hand Length-Left	1	15	16.53±1.65	14.50	21.00	0.260
	2	77	17.07±1.67	10.60	21.00	
	3	22	16.54±1.34	14.50	20.00	
	Total	114	16.89±1.61	10.60	21.00	
Palmar Length-Right	1	15	9.74±1.09	9.00	12.00	0.692
	2	77	10.00±1.15	7.50	13.50	
	3	22	10.02±1.07	8.50	12.50	
	Total	114	9.97±1.12	7.50	13.50	
Palmar Length-Left	1	15	9.72±1.04	9.00	12.00	0.543
	2	77	10.07±1.16	8.00	13.60	
	3	22	10.05±1.11	8.50	12.60	
	Total	114	10.02±1.13	8.00	13.60	
Dominant hand finger length	1	15	7.71±0.89	6.80	9.50	0.241
	2	77	7.99±0.89	6.00	10.20	
	3	22	7.67±0.89	6.50	10.50	
	Total	114	7.89±0.89	6.00	10.50	
Non-dominant hand finger length	1	15	7.83±0.88	6.80	9.60	0.345
	2	77	8.01±0.91	6.00	10.30	
	3	22	7.71±0.82	6.40	10.00	
	Total	114	7.93±0.89	6.00	10.30	
O'Connor Finger Dexterity Test-Right	1	15	8.39±2.22	3.00	10.80	0.038
	2	77	7.07±2.12	2.00	10.06	
	3	22	8.05±2.41	2.32	11.23	
	Total	114	7.43±2.23	2.00	11.23	
O'Connor Finger Dexterity Test-Left	1	15	8.96±2.04	3.01	11.33	0.074
	2	77	7.58±2.18	2.44	11.22	
	3	22	8.06±2.22	2.56	11.26	
	Total	114	7.86±2.20	2.44	11.33	
Purdue Pegboard-Right	1	15	16.00±2.14	12.00	20.00	0.705
	2	77	16.53±2.22	12.00	23.00	
	3	22	16.50±2.50	11.00	22.00	
	Total	114	16.46±2.25	11.00	23.00	
Purdue Pegboard-Left	1	15	15.40±1.88	13.00	19.00	0.769
	2	77	15.30±1.88	11.00	20.00	
	3	22	15.64±2.13	11.00	19.00	
	Total	114	15.38±1.92	11.00	20.00	
Purdue Pegboard-Both hand	1	15	14.13±4.67	11.00	30.00	0.108
	2	77	12.90±3.02	9.00	30.00	
	3	22	11.95±1.36	8.00	14.00	
	Total	114	12.88±3.09	8.00	30.00	
Purdue Pegboard (Assembly)	1	15	8.33±1.40	6.00	11.00	0.216
	2	77	8.30±1.46	5.00	13.00	
	3	22	7.68±1.64	5.00	11.00	
	Total	114	8.18±1.50	5.00	13.00	
Purdue Pegboard (Total)	1	15	53.73±7.56	45.00	76.00	0.421
	2	77	52.94±5.69	42.00	73.00	
	3	22	51.36±4.97	39.00	60.00	
	Total	114	52.74±5.83	39.00	76.00	

N=Subjects's number participated in study; SD=Standard deviation; Min.=Minimum; Max.=Maximum; BMI=Body mass index

Table 5. Comparison of the dexterity tests

Measure		BMI	Gender	O'Connor finger Ability-Right	O'Connor finger Ability-Left	Purdue Pegboard-Right	Purdue Pegboard-Left	Purdue Pegboard-Both hand	Purdue Pegboard (Assembly)	Purdue Pegboard (Total)
BMI	r	1	-0.223	-0.05	-0.085	0.540	0.44	-0.197	-0.138	-0.121
	p		0.017	0.960	0.368	0.569	0.646	0.036	0.143	0.201
Gender	r		1	0.124	0.199	-0.076	-0.167	-0.003	0.048	-0.070
	p			0.187	0.034	0.421	0.075	0.972	0.612	0.458
O'Connor finger Dexterity-Right	r			1	0.852	-0.321	-0.106	-0.314	-0.229	-0.365
	p				<0.001	0.001	0.262	0.001	0.014	<0.001
O'Connor finger Dexterity-Left	r				1	-0.176	-0.232	-0.357	-0.174	-0.339
	p					0.062	0.013	<0.001	0.065	<0.001
Purdue Pegboard-Right	r					1	0.304	0.225	0.318	0.665
	p						0.001	0.016	0.001	<0.001
Purdue Pegboard-Left	r						1	0.378	0.099	0.640
	p							<0.001	0.295	0.001
Purdue Pegboard-Both hands	r							1	0.122	0.749
	p								0.198	<0.001
Purdue Pegboard (Assembly)	r								1	0.474
	p									<0.001
Purdue Pegboard (Total)	r									1
	p									-

Some values such as the hand length (right and left), palmar length (right and left), dominant and non-dominant hand finger, and O'Connor Finger Dexterity Test-Left side showed significant differences between genders. Length measurements were higher in males than in females. Additionally, O'Connor Finger Dexterity Test scores for both sides were lower in males than in females. Moreover, Purdue Pegboard-Right, and Purdue Pegboard-Left, Purdue Pegboard-Both Hands, Purdue Pegboard total were higher in males, whereas Purdue Pegboard (Assembly) was higher in females than in males. However, Purdue Pegboard measurement scores did not show a significant difference between genders ($p>0.05$) (Table 2).

Furthermore, the comparison of the left and right sides by A Paired Samples Test was given in Table 3. Hand length for right and left sides, palmar length for right and left sides, O'Connor Finger Dexterity Test for right and left sides, and Purdue pegboard test for both sides were significantly difference. The correlation coefficient for all measurements was very strong (except the Purdue Pegboard Test, low correlation) (Table 3). Additionally, the values of morphometric and the Dexterity test measurements according to BMI were given in Table 4. Also, a comparison of Dexterity Tests' correlation and significance level were shown in Table 5. There were no significant differences according to BMI (except the O'Connor Finger Dexterity Test-R), and this paper examined whether there was a relationship between the test or not. There was a negative, low level and significant correlation between the O'Connor Finger Dexterity test right, and Purdue pegboard right hand, both hand, assembly, and total measurements ($r<0.400$, $p<0.05$) (Table 5).

DISCUSSION

This paper aimed to evaluate the Dexterity tests and hand morphometry. It was researched whether the dexterity tests and lengths were affected by gender, and body mass index (BMI), hand preferences or not.

Hand morphometry has been studied for many reasons and a long time and one of these reasons is the glove industry. Kwan et al. conducted a study in which they examined hand morphometry with three-dimensional anatomical analysis in 30 subjects and it was seen that the hand morphometric values of males were higher than females. Also, there was no significant difference between the right and left hands in terms of hand morphometry. For this reason, it was stated that producing the same size glove for the right and left hands does not seem to cause many adaptation problems[11]. In our study, males' hand

morphometry values were found higher than females and this was a significant difference ($p<0.05$). However, there were no significant differences between genders according to dexterity tests (except the O'Connor Finger Dexterity Test-L) ($p>0.05$). In the literature, when manual dexterity is evaluated in terms of gender, the values of females are better than males. It was reported that the larger hand size of males was a disadvantage in performing fine motor skills[6]. In another study performed by Riley and Cochran, it was shown that the Purdue Pegboard Test results of females are better than males' results[24]. It might be accepted the large hand sizes were a disadvantage for the Purdue Pegboard Test scores, and the small hand morphometric values of the women were an advantage for the successful results. Furthermore, researchers claimed that gender roles would change if the material sizes used in the Purdue Pegboard Test were made according to larger hands[7]. When comparing the literature findings with this study, we observe that there are differences between our findings. We consider that these discrepancies could be a result of such factors including race, genetic variables, nutritional status, socioeconomic status, and demographic variables including individual, depending on the individual's height, age, and gender.

The Purdue Pegboard test is one of the most widely used tests of hand dexterity to assess the effectiveness of the treatment, rehabilitation, therapy, and level of recovery. Also, the Purdue Pegboard test is a valid and reliable test of dexterity. Dr. Joseph Tiffin an Industrial Psychologist at Purdue University, designed the test in 1948 to evaluate manual dexterity in recruiting assembly workers[9,13]. The fine grip style lets people perform fine-handling tasks and it is very important a component of hand function[9]. Moreover, some researchers suggest that the Purdue Pegboard test does not exactly evaluate the real correlated movement occurring pending fine grip[14]. The present study shows that according to the same hand used, the correlation results of manual dexterity tests between each other were significant and relatively high when compared to contrast hand. In the literature, many studies have been carried out on the speed of performing a task according to hand preference. It has been noted in studies on dexterity tests that the speed of the dominant hand is better than the non-dominant hand[5, 6, 15]. Our study revealed this result (such as the correlation analysis method) with a different perspective. The O'Connor Finger Dexterity-Right side showed a relatively high and significant correlation with the Purdue Pegboard-Right side, while a non-significant and lower correlation with the Purdue Pegboard-Left. On the other hand, the O'Connor Finger Dexterity-Left side showed a relatively high and significant correlation with the Purdue Pegboard-Left side, while a non-significant and lower correlation with Pegboard-Right. It can be said that the dexterity tests of the same side revealed similar results in the test results.

Studies have shown that the motor system that controls the hand works on total control of the posture of the hand rather than the individual fingers. This partly explains why it is difficult to control the fingers independently. For this reason, it is more reasonable to evaluate hand dexterity for the evaluation of hand functions and competencies. In addition, it has been suggested that cortical circuits controlling the preferred hand will potentially demonstrate superior dexterity depending on use[16]. Furthermore, a study performed by Amunts et al., suggested that the contralateral cortex which managed the preferred hand is more intensely interconnected among its neurons than the contralateral cortex which managed the other hand[17]. In the present study, we showed that there were significant differences between the right hand and left hand in terms of hand dexterity which was parallel to the literature.

For many years and due to many reasons, hand dexterity was measured such as the gloves industry, workers recruitment, work capability, assessment of the progression of some diseases, etc [11, 13, 18-20]. It is known that hand assessment is influenced by many factors, such as age, gender, and hand dominance[2-5]. Interestingly a study conducted by Isık et al. showed that menstrual cycles affected task-focused ability and manual dexterity required for the use of tools[19]. Another study that supported this idea noted that manual dexterity performance varied during the menstrual cycle of females[21]. Therefore, we think that before performing a study about manual dexterity in females, the menstrual cycle should be determined carefully for correct results. On the other hand, our female subjects who participated in to study were not in the menstrual period.

The O'Connor Finger Dexterity test, which has been used for almost 100 years, was previously used to recruit females for jobs requiring fine motor skills such as radio assembly, watch assembly, and electrical assembly work[25-28]. Due to this situation, it was demonstrated the watch factory workers' hand

dexterity results were better than general factory workers' result[27]. Recently, it's known that the O'Connor Finger Dexterity Test is commonly used by occupational therapists in treatments and rehabilitation in terms of assessment[12].

The findings of this study showed that Body mass index did not affect manual dexterity. This may be attributed to the lack of participants who were considered obese in our study. We recommend more participants for further research, which can be further and precisely categorized into BMI groups. In a study examining the relationship between motor skills and BMI in children, it was noted that obese children showed lower manual dexterity performance compared to normal-weight children, but there was no real significant difference between BMI groups in terms of manual dexterity. The researchers suggested that this was because the study did not include detailed dexterity tests[22].

A study conducted by Zhang et al. evaluated diabetic polyneuropathy and carpal tunnel syndrome in Chinese individuals and found that both diabetic polyneuropathy and carpal tunnel caused low results in the Purdue Pegboard test and affected dexterity. In addition, they revealed that high grip and compression strength were positively correlated with the Purdue pegboard test scores[23]. This study showed that systemic diseases could affect dexterity as well as strength affects dexterity. However, there are also studies in the literature showing that females' manual dexterity tests are higher than males[6]. As a further study, we anticipate that the study of strength-gender-morphometric analysis parameters together will contribute to the literature.

Hand morphometric measurement values were higher in males than females. O'Connor Finger Dexterity Test results were higher in females than males, whereas, males' Purdue pegboard test scores (exclude Purdue Pegboard assembly) were lower in females than males. Many reasons may be the result of this situation: individual, depending on the individual's current state of mind. Also, as explained above, many factors affect hand dexterity due to the complexity of the structure of the hand. The Purdue Pegboard test and the O'Connor Finger Dexterity test are the basic tests that are most commonly used to measure dexterity. We think that our study will contribute to the literature by presenting reference values in terms of the comparison of these two tests and a comparison of body mass index and hand morphometry in terms of dexterity. As a result, we believe that the data obtained in this study can provide crucial information for therapists and clinicians about hand rehabilitation and they can be used as reference values for evaluating hand morphometry and hand dexterity. We have some limitations to study. Data were collected from a single center. Although the measurements were performed at the same time of the day, fatigue evaluation was not assessed. Additional research utilizing a larger sample would significantly advance the overall research and provide more comprehensive reference data. Moreover, in the next scientific studies, we suggest that the methods of hand dexterity measurements should be chosen according to the aims of measurement.

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