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Validity and reliability analysis of Turkish version of Edinburgh Handedness Inventory

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ABSTRACT

Objectives: The Edinburgh Handedness Inventory (EHI) is the most common tool in determining handedness. It consists of 10 tasks and asks the patient which hand he prefers for those activities. The validity and reliability of the Turkish version of the scale have not been analyzed. Therefore, the aim of this study was to adapt the EHI for Turkish language and to test its validity and reliability.

Methods: The translation of EHI into Turkish was performed by 2 physiotherapists and back-translation was done by a physiotherapist with native English. Healthy young volunteers were enrolled in the study for the validity and reliability analysis. Age, gender and dominant side reported by the participant were recorded. Participants filled the scale twice with a 7-day interval. Test-retest reliability of the questionnaire was analyzed with Pearson's correlation analysis method.

Results: A total of 151 participants (113 females and 38 males) were included in the study and the average age was 22.6 ± 1.7. Only 11 participants reported their dominant side as left. It was seen that self-reported dominant side completely (100%) matched with the scale-based dominant side. It means that all right-handed individuals had positive EHI scores and all left-handed ones had negative scores. EHI test and re-test scores were correlated in an "excellent" level (r: 0.912; p <0.01).

Conclusion: Determination of handedness in a reliable manner is essential for all related fields. The Turkish version of the EHI can be confidently used to determine the handedness for both research and clinical purposes.

Key words: *Edinburgh Handedness Inventory, handedness, hand dominance, reliability, validity*

Introduction

Cerebral lateralization defines the anatomic and functional difference of the cerebral hemispheres. It originates from the asymmetry in the sensorimotor impulses between right and left hemispheres. Asymmetrical difference changes the ability to control over various functions. Hand dominance is one of the most commonly studied asymmetries in human motor behavior and affected from the cerebral lateralization [1]. When one hand shows a significantly better skill during a task compared to the other hand, it is called the hand dominance. Hand dominance may be presented as right or left-handedness or the use of both hands.

Hand dominance does not necessarily represent the cerebral lateralization as it may divert from the hand preference. Hand dominance may be influenced by parental education, cultural factors, genetics and imitation behavior [1]. Therefore, hand preference or

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handedness are more suitable terms to use instead of dominance. Both its development and consequences include multifactorial processes, therefore, hand preference is among the popular research topics of not only medical but also social and educational sciences. The literature includes studies from a wide range of disciplines that are interested in hand preference. As an example, an interesting recent study showed that cerebral lateralization was associated with clinical disease states and thus, determination of hand preference may predict some clinical diseases [2, 3]. Handedness was also reported to affect the memory function in humans according to a very recent study [4]. Besides, hand dominance was also reported to give clues of familial genetics [5]. All those emerging findings about the association of hand preference with various functions raised the necessity of appropriate assessment of handedness. Therefore, it is important to determine the hand preference in a valid and reliable manner since it can affect many factors from education to skills and even to clinical conditions.

Different tools have been developed throughout time to accurately evaluate handedness. Such tools rely on the assessment of the two main dimensions of motor asymmetry, namely direction and degree of handedness [6]. The first dimension- direction- identifies whether an individual habitually prefers to use his right or left hand for uni-manual tasks [7]. The second dimension- degree of handedness- refers how consistently (irrespective of the direction) the preferred hand is used [8]. To determine the handedness in a valid and reliable manner, researchers have been moving from mere dichotomous (right or left) observations from direction to self-reported tools that assess both direction and degree of handedness.

Edinburgh Handedness Inventory (EHI), which was developed by Oldfield in 1971, evaluates both dimensions of handedness [9]. It has been the most popular instrument in the assessment of hand preference with over 30.000 citations according to Google Scholar in December 2019. However, its translated version into Turkish has not been validated so far. Therefore, the aim of this study was to adapt the EHI into Turkish language, and to test the validity and reliability of this version.

Materials and Methods

Healthy young (20-30 years) volunteers were invited to participate in the study. The study plan was explained and the participants who agreed to participate gave written informed consent. The study protocol was approved by local ethics committee of the university.

Individuals with any neurological diseases or any upper extremity injury within the previous 12 months were excluded from the study. Any congenital or acquired conditions that may affect the hand preference (brachial plexus birth injury etc.) were also considered as exclusion criteria.

Age and gender of the participants were recorded and dominant hand (right or left) that the participant reported verbally was also recorded. Then the participants filled in the EHI after a brief instructional demonstration. The participants were invited at a scheduled time for re-test 7 days later.

Translation Procedure

The translation process was performed according to the Beaton's procedure [10]. The original version of the questionnaire was translated into Turkish by two native Turkish speaker physiotherapists. The translators were fully competent in both English and Turkish. Translators constructed one single translation using their individual translations. This agreed Turkish version of the questionnaire was translated back into English by a native English speaker. The three translators gathered to revise the discussive points in meaning and understanding. After agreement, the comprehensibility of EHI was tested on 10 participants. They reported that they could understand all of the questions well and the final Turkish version of EHI was finally created. The results of this testing sample were excluded from the final statistical analysis.

Edinburgh Handedness Inventory (EHI)

EHI includes self-reported 10 items [9]. It measures the participant's hand preference during certain tasks (Figure 1). In this study, we used the instructional information from Espírito-Santo et al. 2017 [11].

The original instructions of the EHI ask the participant to put a "+" for each item in one of the two columns assigned for left- or right hand preference. When the preference is so strong that the responder would never use the other hand unless forced to do so, then he/she puts "++" in the preferred column. If both hands are indifferent for that task, then the responder puts "+" in both columns (right and left). Some activities require the use of both hands. In these cases, the part of the task or object for which the determination of hand preference is to be made is indicated in parentheses (like (match) in the "strike a match" item).

Laterality quotient (LQ) was estimated based on the following calculation: LQ = (R-L) / (R+L) x 100. R refers to the total number of "+"s in the R column and L refers to the total number of "+"s in the L column. Considering the cutoff score of >50, the LQ was used to classify the hand preference of each participant as below [12].

- Score (-100- (-50)): Always left
- Score (0- (-50)): Usually left
- Score (=0): Both equally
- Score (0-50): Usually right
- Score 50-100: Always right

For this study, the above classification was considered as: the scores >0 were taken right-handed and scores <0 were left-handed and scores of 0 were equal use of both hands. Each participant was labelled as right- or left-handed or equal according to his/her first EHI score.

Statistical Analysis

Age and EHI scores were given in mean ± SD while gender and dominant side were given both as percentage (%) and in numbers (n). The dominance according to the direction of EHI scores (minus scores refer to left-handedness or plus scores refer to right-handedness or zero scores refer to equal) was also recorded as an extra variable. The self-reported verbal dominant side and the dominant side determined by the direction of the EHI scores were scanned one by one for each participant in the whole sample. Any mismatch between those two dominant side assessments was recorded to analyze the validity. For reliability analysis, test and retest correlation of EHI scores was performed by Pearson correlation analysis. The statistical significance was accepted as $p<0.05$.

Results

A total of 151 participants (113 females and 38 males) enrolled into the study. The mean age was 22.6 ± 1.7. The rate of right-handedness reported by the participant was 92.7% of the participants while left-handedness was seen in only 7.2%. These results were given in Table 1.

The mean EHI scores was 58.64 ± 41.6 (between 100- (-100)) among the whole sample. In right-handed participants, the average EHI score were 68.3±24.64 (range: 100-10), while it was -58.6 ± 31.1 (range: -100-(-20)) among the left-handers. The right-handers and left-handers were similar regarding age (22.6 ±1.7 and 22.6 ± 0.6 respectively, $p>0.05$).

There was a complete (%100) match between the participant-reported and scale-based handedness. It means that all right-handed individuals had positive EHI scores and all left-handed ones had negative scores. There were no participants with 0 (zero) EHI score. Reliability analysis was performed in 111 subjects and the correlation tests revealed that test-retest of the EHI scores showed an excellent correlation ($r=0,912$; $p<0.01$).

Discussion

EHI, the most common tool in determination of the handedness, was adapted into Turkish language in this study and the results showed that this version is valid and reliable.

Hand preference refers to an individual's consistent

Edinburgh El Tercihi Envanteri

Tarih:

Adı-soyadı:

Doğum tarihi

Cinsiyet:

Lütfen aşağıdaki aktivitelerde el kullanımındaki tercihlerinizi uygun kolona + koyarak belirtin. Tercihiniz, diğer eli zorlama olmadıkça kullanmayı kesinlikle denemeyecek kadar güçlü olduğunda ++ koyun. Eğer herhangi bir durumda gerçekten fark etmiyorsa, her iki kolona da + koyun.

Bazı aktiviteler her iki eli gerektirir. Bu durumlarda, işin veya objenin bir kısmı için hangi el tercihi isteniyorsa parantez içinde belirtilmiştir.

Lütfen tüm soruları cevaplamaya çalışın ve yalnızca, obje veya işte hiç deneyiminiz yoksa boş bırakın.

		SOL	SAĞ
1	Yazı yazma		
2	Çizme		
3	Fırlatma		
4	Makas		
5	Diş fırçası		
6	Bıçak (çatal olmadan)		
7	Kaşık		
8	Süpürge (üstteki el)		
9	Kibrit çakma (kibrit)		
10	Kutu açma (kapak)		
i	Hangi ayağınızla vurmayı tercih edersiniz?		
ii	Tek gözü kullanırken hangisini kullanırsınız?		

Figure 1. Turkish version of Edinburgh Handedness Inventory.

Table 1. Mean age and distribution of gender and dominance among the participants.

Age	22.6 ± 1.7	
Gender	113 females (74.3%)	38 males (25.7%)
Handedness (self-reported)	140 R (92.7%)	11 L (7.2%)
Handedness (scale-based)	140 R (92.7%)	11 L (7.2%)

tendency or preference to use one hand instead of the other when performing a task [13]. It primarily develops according to the hemispheric dominance, thus hemispheric lateralization is not lonely but a strong predictor hand dominance [14]. However, cultural and social influences sometimes have a great effect on hand preference even in the opposite direction of the hemispheric dominance. Therefore, handedness does not always reflect the cerebral lateralization and it is not as simple as being right- or left-handed. Instead, it is a complicated variable. However, in practice, it is very common to determine the handedness by asking the patient verbally. And it is generally a short question like "are you a right- or left-hander?" Using such a dichotomized variable (right or left) appears to be practical in a busy clinic, however, handedness should be assessed in a more standardized manner especially for research purposes.

Moreover, there are some other studies that used the observational approach in determining the handedness- e.g. watching the individual while drawing a circle [15]. However, preferred hand can change from one task to another. Nevertheless, handedness consists of consistency of the hand preference among different tasks [8]. For those reasons above, determination of handedness in a valid and reliable manner urges. As it is in the focus of various research fields from educational to medical sciences, standardization of its assessment is also necessary. Besides standardization, its assessment should also include both the direction and degree of the preference. EHI, including both dimensions, is the most commonly used tool in the field. It has been translated into many languages, however, Turkish version has not been validated so far [14]. According to the results of this study, the adapted version can be used confidently with an excellent degree of reliability.

EHI has been originally developed by Oldfield and its most common used form has been the 10-item one [9]. It has a standard calculation and scoring system. Throughout time, it has been modified regarding both item reduction and scoring, however, the original form has still been the most used one [14]. As no previous studies have analyzed any Turkish adapted version of the tool so far, we preferred to analyze the original form firstly. Reproduced forms can be in the focus of future studies.

Previous studies showed that nearly 90% of human population is estimated to be right-handed and the remaining 10% to be left-handed [6,16]. Similar to previous findings, our study also showed that 92.7% of the young adults are right-handed where 7.2% of them are left-handed.

It is obvious that this study has a simple design and this may bring out some possible limitations. Firstly, this study has mainly focused on the validity and reliability of the language adaptation of the EHI. Therefore, any other measurements were not included. Besides, validity analysis normally requires a comparison of the results to a valid tool's results. However, in this study, I had to asked the dominant side to the patient verbally as no other handedness assessment tools have been validated in our language so far. Moreover, cultural influences should have been taken into account in the study design as they have the potential to affect the handedness of an individual [14]. Regarding this cultural issue, the results of this study can be interpreted confidently as some other studies showed no difference in hand preference across different urban and rural areas [11,14].

Overall, this adapted Turkish version of the EHI has proven to be a valid and reliable instrument to assess hand preference in young healthy adults, being easy and practical to apply. It provides information regarding both the direction and degree of hand preference. Its use would help scientists and clinicians to

explore the architecture and functionality of the brain. Other potential influencers need more exploration in future studies.

Conflict of interest statement

The author has no conflicts of interest to declare.

References

1. Marcori AJ, Monteiro PHM, Okazaki VHA. Changing handedness: What can we learn from preference shift studies? Neurosci Biobehav Rev 2019;107:313-9.
2. Neveu PJ. Cerebral lateralization and the immune system. Int Rev Neurobiol 2002;52:303-23.
3. Van Strien JW, Bouma A, Bakker DJ. Birth stress, autoimmune diseases, and handedness. J Clin Exp Neuropsychol 1987;9:775-80.
4. Loprinzi PD, Franklin J, Farris A, Ryu S. Handedness, Grip Strength, and Memory Function: Considerations by Biological Sex. Medicina 2019;55:444.
5. Medland SE, Duffy DL, Wright MJ, Geffen GM, Hay DA, Levy F, et al. Genetic influences on handedness: data from 25,732 Australian and Dutch twin families. Neuropsychologia 2009;47:330-7.
6. Edlin JM, Leppanen ML, Fain RJ, Hacklander RP, Hanaver-Torrez SD, Lyle KB. On the use (and misuse?) of the Edinburgh Handedness Inventory. Brain Cogn 2015;94:44–51.
7. Andersen KW, Siebner HR. Mapping dexterity and handedness: recent insights and future challenges. Curr Opin Behav Sci 2018;20:123-9.
8. Lyle KB, Dombroski BA, Faul L, Hopkins RF, Naaz F, Switala AE, et al. Bimanual coordination positively predicts episodic memory: A combined behavioral and MRI investigation. Brain Cogn 2017;118:71–9.
9. Oldfield, Richard C. The assessment and analysis of handedness: the Edinburgh inventory. Neuropsychologia 1971;9:97-113.
10. Beaton DE, Bombardier C, Guillemin F, Ferraz MB. Guidelines for the process of cross cultural adaptation of self-report measures. Spine 2000;25:3186-91.
11. Espírito-Santo H, Freitas C, Queiroz I, Daniel F, Gomes A, Fazio RL. Preliminary validation of the Portuguese Edinburgh Handedness Inventory in an adult sample. Appl Neuropsych-Adul 2017;24: 275–87.
12. The Edinburgh Handedness Inventory. Available via: https://www.psytoolkit.org/survey-library/handedness-ehi.html (Accessed: September 16, 2020).
13. Donaldson, G, Johnson G. The clinical relevance of hand preference and laterality. Phys Ther Rev 2006;11:195–203.
14. Albayay J, Villarroel-Gruner P, Bascour-Sandoval C, Parma V, Gálvez-García G. Psychometric properties of the Spanish version of the Edinburgh Handedness Inventory in a sample of Chilean undergraduates. Brain Cogn 2019;137: 103618.
15. Angstmann S, Madsen KS, Skimminge A, Jernigan TL, Baaré WF, Siebner HR. Microstructural asymmetry of the corticospinal tracts predicts right-left-differences in circle drawing skill in right-handed adolescents. Brain Struct Funct 2016;221:4475-89.
16. Jang H, Lee JY, Lee KI, Park KM. Are there differences in brain mor-phology according to handedness? Brain Beha 2017;7:e00730.

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