

Remote Neuropsychological Assessment: Teleneuropsychology

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ABSTRACT

Introduction: Teleneuropsychology, which includes the remote application of neuropsychological tests to patients via telephone or videoconferencing, can expand access to health services for patients who reside in distant areas or have mobility restrictions. With the emergence of the COVID-19 pandemic, there has been a significant increase in the use of teleneuropsychology in cognitive assessment. In this review, the aim was to critically review the results of studies conducted in the field of teleneuropsychology and the fundamental principles related to teleneuropsychological assessment. Additionally, the “guideline for home-based teleneuropsychology” developed for Türkiye’s practices is outlined in this review.

Method: A literature search was conducted using the Web of Science and PubMed databases to include all types of articles related to the subject.

Results: The results of studies on in-clinic and home-based teleneuropsychological assessment indicate that tests that assess cognitive functions such as attention, memory, executive functions,

and language, particularly those based on verbal administration, can be reliably applied through teleneuropsychological assessment. However, there are factors to consider when referring patients for teleneuropsychological assessment, selecting tests for assessment, and making ethical considerations. Additionally, it is important to follow recommended steps for both the clinician and the patient and/or their caregiver before and during the interview in order for the assessment to be carried out effectively.

Conclusion: Although direct contact with the patient is an essential element in clinical neuropsychology practice, when necessary, teleneuropsychological assessment performed by trained experts following appropriate application procedures can be a good alternative to face-to-face evaluations.

Keywords: cognitive assessment, neuropsychology, practice guideline, telemedicine, teleneuropsychology

Cite this article as: Yıldırım E, Soncu Büyükişcan E, Akça Kalem Ş, Gürvit İH. Remote Neuropsychological Assessment: Teleneuropsychology. Arch Neuropsychiatry 2024;61:167–174.

INTRODUCTION

Face-to-face interviews are important for both establishing a secure relationship between the clinician and the patient and for the clinician to evaluate the patient in a detailed and holistic manner. Therefore, face-to-face interviews are considered the gold standard in clinical practice. However, when face-to-face interviews are not possible due to distance or other factors, telemedicine services, which are similar to face-to-face interviews and proven to be reliable and effective, can be offered (1). Telemedicine is defined as the provision of health services through phones, smartphones, or other mobile devices (2). Especially from the beginning of early 2000’s, the use and prevalence of telemedicine applications have increased with the expanding developments in communication and information technologies. Subsequently, teleneuropsychology has started to develop as a branch of telemedicine.

Teleneuropsychology involves conducting neuropsychological assessments or treatments (neurorhabilitation) to patients via phone and videoconferencing. However, the majority of current studies and practices in the field have focused on teleneuropsychological assessment, which is also the subject of this review. In teleneuropsychological

Highlights

- Teleneuropsychological evaluations have increased with the Covid-19 pandemic.
- Tests that rely on verbal administration are appropriate for teleneuropsychological assessments.
- It is important to follow the recommended practice steps for direct-to-home assessments.
- Teleneuropsychological assessment can be an alternative to in-person assessment.

assessment, both the patient and the neuropsychologist connect to videoconference via the Internet using a device (computer or tablet) with a front camera, a working microphone, and a speaker. This setting enables neuropsychological tests to be administered remotely to patients. It is argued that teleneuropsychology has two main advantages. One is to overcome access restrictions caused by the uneven

geographical distribution of experts in the field; the other is to offer an alternative evaluation opportunity to individuals with rare diseases that require detailed and multidisciplinary assessment and examination, and who, under normal circumstances, would need to travel long distances (3,4). Despite these advantages, since a direct contact with the patient is important in clinical neuropsychological assessment (5), teleneuropsychology was not commonly preferred in routine practice until recent years (6). However, the worldwide COVID-19 pandemic, with its social distancing rules and restrictions, has become an obstacle to face-to-face evaluations. As a result, teleneuropsychology has been included more in clinical practice and the number of studies focusing on this field has accelerated (7).

Initial studies on teleneuropsychology have focused on the feasibility and validity of teleneuropsychological practices (8,9). Subsequent studies have generally indicated that the findings of neuropsychological evaluations conducted face-to-face and via videoconferencing largely overlap and that remote neuropsychological assessment, when performed following necessary steps and recommended application procedures, can be a good alternative to face-to-face assessment (10-14).

In teleneuropsychological assessment, two different application models can be used. In the clinic-based (clinic-to-clinic) approach, the neuropsychologist and the patient are located in different health centers or in different rooms of the same clinic. Applications conducted within the same center are often used in scientific studies that examine the suitability of the method (9,11). In this model, there is often a technician responsible for setting up the environment for the patient to join the videoconference, starting the devices and videoconference application, orienting the patient, and distributing and collecting test forms (15). In the second model, home-based applications (clinic-to-home), the patient participates in the videoconference from their home while the neuropsychologist is at the clinic. There are also home-based (home-to-home) applications in which both the neuropsychologist and the patient are in their own homes (16,17). In home-based applications, the presence of a companion is allowed in case patients require technical support (18). In this model, controlling external stimuli and distractions that might affect test performance (19) and standardizing factors related to technological devices and connection speed might be quite challenging.

In both clinic-based and home-based models, an important issue pertains to deciding the timing, selection, and application method of tests, as well as deciding to which patient group these tests should be applied. There are many studies in the literature that share recommendations regarding teleneuropsychological assessment procedures, precautions to be taken regarding test security, and ethical rules (4,17,20). After the COVID-19 pandemic, teleneuropsychology practice guidelines have been published by organizations such as the International Neuropsychological Society (INS; 21) and the Inter Organizational Practice Committee (IOPC; 19, 22). In Türkiye, despite an interest in teleneuropsychology, there are very few studies on this subject. Furthermore, there is no published guidelines for teleneuropsychological assessment in Türkiye. In this context, this review aims to review the basic principles related to teleneuropsychological assessment by examining the results of studies on the subject. Another aim of this review is to share a practical guide for teleneuropsychological assessments to be conducted in Türkiye.

METHOD

For this study, a literature search was conducted using the PubMed database, which indexes publications focusing on clinical and biomedical

studies, and the Web of Science database, which includes high-quality journals in an interdisciplinary manner. A search was performed for publications containing any of the keywords "teleneuropsychology," "TeleNP," "direct to home neuropsychology," and "home-based teleneuropsychology", covering publications until June 2023. After removing duplicate studies, 121 abstracts were obtained. Nineteen articles that did not have full text or were not in English were excluded. Upon review by the authors, 38 publications that analyze the results of teleneuropsychological assessment and offer recommendations or share practice guidelines for teleneuropsychological assessment were included in the current review.

RESULTS

In guidelines offering recommendations related to teleneuropsychological assessment (4,17-20,22), suggestions are made regarding referral of the patient, obtaining informed consent for teleneuropsychological assessment, selection of neuropsychological tests, and maintaining confidentiality of the service provided over the internet. Recommendations and precautions that should be taken before and during the assessment are also specified. These topics will be examined in this review, as well.

Referral of the Patient

Studies suggest that teleneuropsychological assessment can be applied to all age groups from the age of 6 (23) and can be used in the evaluation of several different neurological and psychiatric diseases such as dementia (16), multiple sclerosis (24), stroke (25), movement disorders (26), epilepsy (27), and attention deficit hyperactivity disorder (28). However, patients experiencing serious perceptual (vision and hearing) or motor disturbances, those in acute confusional state, those unable to sustain their attention for longer than 30 minutes, or those showing severe communication difficulties, as well as individuals diagnosed with advanced-stage dementia, are deemed unsuitable for teleneuropsychological assessment. For these patients, remote evaluations, including even short screening tests, are not considered reliable (12,29,30).

Still, not every suitable patient should be directly referred for teleneuropsychological evaluation. At this point, there are two main factors that the referring neurologist or psychiatrist should consider: necessity and urgency (31). The clinician should decide how urgent and necessary the assessment is for the safety and well-being of the patient and then make the referral. For example, determining whether a patient would be a candidate for deep brain stimulation can be categorized as both necessary and urgent; whereas the neuropsychological assessment of an elderly patient who has subjective memory complaints accompanying depressive symptoms, which do not affect functionality, can be considered necessary but relatively less urgent in terms of the possibility of dementia. However, it should be noted that teleneuropsychological assessments conducted with patients for whom neuropsychological evaluation is of critical importance (such as cases requiring pre-surgical assessment, forensic cases, etc.) may have lower reliability due to the lack of clinical observation (29). Therefore, the assessment carries the risk of leading to incorrect or inadequate diagnosis and treatment.

Technological Requirements

Certain basic technological requirements need to be satisfied for a teleneuropsychological evaluation. The assessments should be carried out via devices with appropriate screen size, front cameras, and speakers functioning at an optimal level. Particularly for the evaluation of visuospatial functions, using desktop computers, laptops, or tablets with a camera and at least 7-inch (17 cm) screen size is recommended (22,30).

However, there are also studies that recommend screen sizes of 9.75 or 13 inches (19).

In order to ensure that interviews are not interrupted, the speed of visual and auditory data transmission or bandwidth must be above acceptable values. Indeed, the bandwidth used in most studies varies between 384 kbit/s and 1 Mbit/s (32). Therefore, a fast connection speed with high bandwidth (preferably, above 1 Mbit/s) that prevents a reduction in image quality is recommended (33). It is also suggested among other recommendations that the neuropsychologist can increase the internet connection speed by increasing the bandwidth in the band settings and check the connection speed via online speed tests before each interview (20,22).

Another important issue concerns the selection of the videoconference platform. International studies mention videoconferencing applications such as Skype for Business®, Zoom®, Doxy.me®, Google G Suite Hangouts®, and Amazon Chime® (30). It is important to choose video conferencing applications that can adapt to bandwidth changes without causing disconnection, have no time limit, and allow for screen sharing.

In addition to the specified technological requirements, the use of a second camera is recommended in both clinic-based and home-based application models. For instance, in some clinic-based applications, two cameras are used, one directed at the patient and the other at the surface of the table the patient is using, thereby allowing a more detailed evaluation of the patient (13). In home-based assessments, it is stated that for tests where the patient's movements need to be observed (e.g., clock drawing, block design tasks, etc.), the patient or a family member might be asked to change the angle of the camera, if possible (3), or if there is another device with a camera available (such as a smartphone), this device can be incorporated to the videoconference to enable the clinician to observe the movements of the patient (34). In general, hospital settings satisfy the technological requirements for clinic-based applications. It is, however, also necessary to check whether the specified requirements are met for home-based applications (16,18). For this, conducting a preliminary interview with the patient either by phone or face to face is recommended.

Patient Privacy and Test Security

Using email or internet-based videoconferencing applications in teleneuropsychology poses risks in terms of privacy (29). Thus, the use of platforms that are compliant with data security laws is mandatory in some countries like the United States. In countries where there are no relevant legal regulations, it is the responsibility of the neuropsychologist to prefer videoconferencing platforms that secure the personal health information of patients and that encrypt the transmission of auditory and visual data. On the other hand, there are also risks related to the security of test materials in teleneuropsychological assessment (4). In order to ensure test security, patients need to be informed that photos of the test materials should not be taken, and audio and video recordings should not be made during the interview (19,21). In addition, disabling the recording option on the videoconferencing platform can prevent the interview from being recorded by the other party.

Environmental Arrangements

External stimuli and distractions affect neuropsychological test performance (27). Therefore, the patient should be in a room that is as quiet and well-lit as possible. In clinic-based applications, these environmental factors can be controlled more easily (32). However, controlling environmental factors in home-based assessment is of great importance for the validity of the assessment, as well. Established protocols (35,36) state that the neuropsychologist should give instructions to the patient and/or the patient's caregiver before the interview; these may include asking them to turn off noise-making devices at home (like

televisions and vacuum cleaners), to keep small children or pets away from the room where the interview will take place, and ensuring that the companion's cell phone is off or in silent mode. These conditions should be checked before starting the interview.

Obtaining Informed Consent

Obtaining informed consent from the patient or their caregiver is important for teleneuropsychological assessment (19,22). The informed consent must include information on how communication will be established through the telecommunication tool to be used and that limitations may arise due to certain differences in application (19,23,29,36). Issues that should be addressed related to limitations include:

- Some modifications have been made to the tests to adapt face-to-face evaluations to videoconference sessions, and the impact of these changes on test performance is not yet fully known.
- The videoconference application might induce additional anxiety in patients.
- Being unfamiliar with technology might impact test performance.
- The richness of clinical observation may be lost due to behaviors and reactions outside the camera angle not being observable.

Informing individuals that the data will be kept confidential is also important for consent. If certain test performances of patients will be recorded, permission must be obtained from the patient and/or their caregiver, and it should be stated that these records will be destroyed after scoring (36). In addition, the patient and/or their caregiver should be notified not to take audio and visual recordings of the session for the sake of test security. Lastly, the patient or their caregiver should also be informed about the pricing and billing related to the service to be provided. Since obtaining written informed consent can be practically

Informed Consent Form for Teleneuropsychological Assessment		
Before starting the videoconference application, we discussed the following topics with the expert who will conduct the test and reached a consensus on the following issues:		
I was informed that the videoconference session would be conducted via the Zoom application, and the meeting link was sent to me/my caregiver. General information regarding the use of the application was provided.		
I was informed that I should access the videoconference application from my computer or tablet and that my camera and microphone should be on during the meeting.		
The importance of being in a quiet and private place away from distractions (such as mobile phones) during the meeting was emphasized.		
It was noted that joining the meeting via a secure private internet connection rather than a public and open wireless network connection is essential.		
It was stated that neither party would record the videoconference meeting.		
A phone number of an expert was provided to me in case I needed to contact them if a technical problem emerged during the meeting.		
I was informed that some of the tests to be applied during the videoconference were modified, and these changes could affect the test results.		
It was reported that being inexperienced in computer use could lead to problems during the assessment, and therefore, a companion could attend the meeting as an observer without interfering with test performance.		
Name:	Date:	Signature:

Figure 1. Sample informed consent form

Table 1. Results from tests that are used in teleneuropsychological assessment and application recommendations

Name of the test	Results	Recommended modifications
MMSE	FF=VC (8,10,12,14)	While assessing time orientation, patients can be asked to either look away from the screen or close their eyes. This would enable the tester to prevent them from seeing the date and time information displayed on the screen. Visual stimuli might be presented via screen sharing option. For items assessing copying and writing skills, the patient can be asked to hold the paper in front of the camera, and a screenshot may be taken.
MoCA	FF=VC (12,25) VC > FF (26,38)	Same with MMSE
Digit span (forward – backward)	FF=VC (10,13,34) FF > VC (14,38,39) – for forward digit span	Trials should not be repeated, except when sequences are not heard due to technical problems.
Symbol Digit Modalities Test	FF=VC (11,24)	-
WAIS – Similarities	FF=VC (34)	-
Oral Trail Making Test	In Form A: FF > VC; in Form B: FF=VC (14)	-
Clock Drawing Test	FF=VC (10,12-14) VC > FF (9)	The patient might be asked to face the camera toward the drawing so that the clinician can observe their planning ability. A screenshot may be taken when the patient is asked to show their drawing to the camera.
WAIS – Vocabulary	FF=VC (9,11,34)	-
Boston Naming Test	FF=VC (12,13) FF > VC (14)	Visual stimuli may be shown via screen sharing option.
Semantic Fluency	FF=VC (12,14,38) FF > VC (13,39)	-
Lexical Fluency	FF=VC (9,12-14,38,39)	-
Word list learning test (Rey Auditory Verbal Learning Test, Hopkins Verbal Learning Test)	Immediate memory: VC > FF (9,12), FF=VC (13,14); delayed recall: FF=VC (12-14,38)	Patient should be instructed not to write down or record the items in the list. The patient should be carefully observed to make sure they are not recording the items on the list.
WMS – Logical Memory	Immediate memory: VC > FF; delayed recall: FF=VC (11,34).	Same with word list learning tests

FF: Face-to-face; MMSE: Mini Mental Status Examination; MoCA: Montreal Cognitive Assessment; VC: Videoconference; WAIS: Wechsler Adult Intelligence Scale; WMS: Wechsler Memory Scale.

difficult, consent with an e-signature can be obtained, or more practically, verbal consent can be recorded via a camera (18).

Selection of Tests to be Administered

The tests to be used in teleneuropsychological assessment must be reliable; that is, patients' test performances should be similar in both face-to-face and videoconference applications. The results of meta-analysis and systematic review studies that include studies examining the reliability of tests particularly indicate that the administration of tests relying on verbal application via videoconferencing is reliable (15,37). However, it is also noted that, especially with regard to visuospatial function assessment, variations in image and sound quality due to internet connection, the distance of visual stimuli to the camera, or differences in scoring, can pose problems in terms of reliability (37).

The majority of studies on home-based applications (24,34,38) report that tests that rely on verbal application are reliable, and hence their findings overlap studies based on clinic-based applications. Only in one study (39), the performance obtained from teleneuropsychological assessment was found to be higher compared to face-to-face

assessment. However, it should be kept in mind that in this study, the order of applications (face-to-face vs. videoconference) was not counterbalanced. Therefore, participants might have shown higher performance in the teleneuropsychological assessment due to a learning effect.

When selecting the tests to be administered, care should be taken to consider those that are recommended for use in teleneuropsychological assessments and to ensure that the duration of testing does not exceed 90 minutes (12,40). In addition, it should not be forgotten that some modifications need to be made in terms of the presentation of the test material in videoconference sessions. For example, showing visual stimuli to the patient by holding them up to the screen will both reduce image quality and distract attention (30). Therefore, it is recommended to display stimuli that are converted to PDF or Office PowerPoint format and transferred to a digital medium without changes in image size and quality, and then presenting them via the "screen sharing" feature in videoconference applications in full-screen mode. Table 1 demonstrates the results related to the tests used in teleneuropsychological assessment studies and recommendations for practice.

Teleneuropsychology Studies in Türkiye

There are very few studies conducted in Türkiye related to teleneuropsychology. In one of the studies examined independently of the review conducted within the scope of the review, the reliability of application of the Addenbrooke Cognitive Examination-Revised Version (ACE-R) via teleneuropsychology in the Turkish population has been investigated (41). Preliminary findings of the study, which included healthy participants aged 50 years and above, suggest that ACE-R can be appropriately administered via videoconference under necessary circumstances and with specific modifications (such as ensuring that certain technological requirements like screen size and connection speed are met, updating some instructions specifically for videoconference applications, etc.). Another study (42) examined the reliability of administering a comprehensive test battery assessing attention, executive functions, memory, language, and visuospatial functions through videoconferencing in healthy elderly individuals and patients with cognitive impairment (mild cognitive impairment and early-stage Alzheimer's type dementia) aged between 50 and 85 years. Preliminary findings of this study, which utilized a within-subjects design and counterbalanced the order of assessment sessions (face-to-face and videoconferencing), indicate that the scores of tests based on verbal application are compatible in both face-to-face and videoconference applications.

There is not yet any published protocol with recommendations for conducting teleneuropsychology applications in Türkiye. Although the text titled "Recommendations of the Turkish Neurology Association Regarding the Use of e-Health, Tele-Health, and Telemedicine Systems in Neurology", published on the website of the Turkish Neurology Association (43), states that brief neuropsychological tests such as MMSE and MoCA can be administered for screening purposes, it does not contain any recommendations for application. To address this deficiency and for the benefit of clinicians working in the field, the home-based teleneuropsychology practice guide followed by Yıldırım et al. (42) has been shared in this review.

Home-Based Teleneuropsychology Practice Guide

A preliminary interview is conducted either face-to-face or over the phone with the patient and/or their caregiver for neuropsychological assessment to be conducted via videoconference as per the prepared protocol. In this preliminary interview, information is provided regarding the purpose, method, benefits, and limitations of teleneuropsychological assessment. Then the interviewer checks whether the patient can meet the technological requirements. Below is a list of matters recommended to be addressed in the preliminary interview:

- Inquiring about the features that the device used by the patient should have.
- Inquiring about the features that the internet connection used by the patient should have (such as time or data limits).
- Checking whether the videoconference application to be used is installed on the patient's computer, and if not, providing necessary information for installation (an installation file can be sent to the patient).
- Inquiring about the patient's experience with using computers and videoconference applications, and indicating that the patient can seek assistance from a technologically proficient person if they feel inadequate.
- If someone will provide technological assistance, specifying the role of this person in the interview (such as remaining silent during the interview).

- Informing on what to do in case of disconnection or device-related issues (e.g., trying to reconnect, calling the neuropsychologist by phone).
- Informing the patient that they need to be in a quiet and well-lit environment that is free from distractions (with phones and televisions turned off, etc.) during the interview.
- Explaining the confidentiality of test materials and instructing the patient not to take visual and audio records of the materials.
- Obtaining a phone number to contact the patient or their caregiver and an email address to send the meeting link, in case of connection issues or the meeting address not working.

For those who meet the technological requirements and accept the interview, an appointment is scheduled for the teleneuropsychological assessment. After the appointment is set, the link for the session is sent to the patient and/or caregiver a day prior to the scheduled appointment through email or instant messaging applications. The regulation titled "Regulation on the Provision of Remote Health Services," published in the Official Gazette on February 10, 2022 (44), lists what patients should be informed about before the provision of telemedicine services in Türkiye, but there is no indication in this text regarding the necessity of obtaining informed consent. However, since both international practices and the Telepsychology Guide published by the Turkish Psychologists Association (45) state that a specifically prepared informed consent should be obtained for videoconference applications, informed consent is also included in this protocol. Here, the informed consent form is sent to the patient and/or their caregiver via email before the assessment interview.

Before starting the videoconference session, the neuropsychologist needs to make certain adjustments on their computer. Below are the suggested adjustments:

- Disabling the recording feature in the videoconference application to ensure that the session will not be recorded.
- The neuropsychologist should use a standard background that resembles a classic office room during the session in order to minimize distractions for the patient.
- In one-to-one sessions with the patient, the neuropsychologist should use the feature in the videoconference platform that allows only seeing the image of the other party, in order to observe the patient better.
- Before screen sharing, the neuropsychologist should minimize or close other programs and websites that are currently working on their computer.

After making these adjustments, the neuropsychologist should check the environment where the patient is located and inform the patient about test security and the emergency plan before beginning the assessment.

These steps are listed below:

- Checking whether the patient's speaker and monitor are working at optimum quality.
- If the patient is using a laptop or tablet, making sure that these devices are plugged in.
- If the patient wears glasses, ensuring they are within reach.

- Ensuring that all materials needed by the patient during the assessment (a pencil and three pages of blank white paper) are prepared and accessible.
- Ensuring the patient is seated at an appropriate distance from the monitor or camera and is sitting in a comfortable position.
- Directing the patient to ensure that the camera is in an optimal position for observation.
- Making sure the patient is in a quiet environment, free from distractions that could divert attention during the session (devices such as phones, televisions turned off, etc.).
- Obtaining the address of the location where the patient is during the session and the contact information of the person to be contacted in case of an emergency (like an epilepsy seizure).
- Informing the patient or their caregiver of the steps that will be taken if the connection is lost (such as reestablishing the internet connection, calling the patient if they are unable to connect, postponing the session if the internet connection cannot be established within 10 minutes, etc.).
- Sending a link to the patient for a speed test to check the connection speed (e.g., www.speedtest.net).
- A short training might be provided to the patient or their caregiver on how to use the videoconference platform. In order to reduce the patient's anxiety, the patient can be asked to make a drawing and hold it properly to the screen, and a screenshot might be taken.

After these checks and briefings, the neuropsychologist proceeds to administer the tests in accordance with the recommendations provided in Table 1.

DISCUSSION

The current review aimed to critically examine the results of studies related to teleneuropsychology within the framework of neuropsychological assessment via remote videoconferencing and the fundamental principles of teleneuropsychological assessment. Although clinically, face-to-face neuropsychological assessment is considered the gold standard, current results indicate that neuropsychological tests, especially those based on verbal application such as digit span, word list learning tests, fluency tests, and naming tests, can be reliably administered in teleneuropsychological evaluations. Indeed, a study conducted in Türkiye (42) similarly noted that the use of digit span, Öktem Verbal Memory Processes Test, Öktem Auditory Trail Making Test, Boston Naming Test, fluency tests, and clock drawing test are reliable in teleneuropsychological assessment of patients with mild cognitive impairment and Alzheimer's type dementia. In contrast, there is a significant need for studies investigating how tests for visuospatial function, motor skills, and executive function, which are more challenging to administer via videoconference, can be incorporated into teleneuropsychology practice (15,30).

Despite its advantages, teleneuropsychological assessment is not suitable for all patient groups, and the inability to capture patient behaviors and test performances that occur out of the camera's view constitutes significant limitations in terms of assessment (6). Moreover, concerns regarding test security and the security of information technologies also create limitations for teleneuropsychology. Additionally, it's crucial for both the neuropsychologist and the patient and/or the caregiver to follow the recommended steps before and during the assessment for an effective teleneuropsychological assessment.

In Türkiye, the number of healthcare centers where clinical neuropsychological assessment is conducted is quite insufficient, and these centers are not distributed in a geographically-balanced fashion. From this perspective, the use of teleneuropsychology in the neuropsychological assessments of patients who are physically distant from the healthcare center or who have difficulty accessing the center can be beneficial. At this point, the involvement of institutions providing teleneuropsychology services and the establishment of cooperation between these institutions and others will facilitate patient's access to healthcare services. On the other hand, there are certain conditions in Türkiye that could inhibit the implementation of teleneuropsychology. These can be categorized into three groups: difficulty in accessing technology, challenges related to internet connection, and control of environmental stimuli.

According to the results of the household information technology usage conducted by the Turkish Statistical Institute (TÜİK) in 2022 (46), the proportion of homes with desktop computers is 15.8%; and the proportion of homes with portable devices such as laptops, tablets, or netbooks is 36.1%. These numbers are believed to be even lower for elderly individuals. In developed countries, on the other hand, these rates are over 80%. Therefore, similar to other developing countries (3,30), the limited access to technology in Türkiye constitutes an obstacle to the fair delivery of teleneuropsychological assessments or other telemedicine services to patients. In this regard, implementing teleneuropsychological assessments via telephone (47), and adapting some basic measurement tools for telephone interviews might be a solution. Additionally, providing patients with loaner computers by healthcare institutions can also be used as an alternative solution (29).

The TÜİK report (46) indicates that 90.7% of households have internet access. However, interruptions, lags, and delays in video or audio might emerge due to issues related to infrastructure during teleneuropsychological assessments. Thus, clinicians are recommended to check connection speed before starting the assessment, and in cases of low speed or consecutive connection losses, global screening tests without time limitations should be utilized (18). For non-repetitive disconnection, the application of tests primarily independent of attention and short-term memory; and those that evaluate language, executive functions, and visuospatial skills, can resume from where they were interrupted. Tests with alternative forms and with no learning effect can be reapplied (29,32). Additionally, when absolutely necessary, after ensuring the patient's cooperation, tests based on verbal application can be administered either with the camera turned off or with the camera of the phone turned on.

The most commonly encountered challenges include the testing environment of the patient not being suitable or being too noisy. These problems can be minimized by informing the patient and their caregivers on these matters during the preliminary interview and performing necessary checks starting the assessment. If these problems are still encountered during assessment, the clinician might provide instructions aimed at reducing distractions (such as silencing the phone, closing windows to avoid city noise, shutting the room door, etc.) (18,29). If a test is interrupted or invalidated, recommendations that are suggested in case of the internet disconnection can be activated.

In conclusion, it can be suggested that teleneuropsychological assessment, when conducted adherently to recommended application guidelines and ethical principles, could be an alternative to face-to-face assessment in cases where the patient is far from the health center or due to other factors like limited mobility of the patient or mandatory social distancing, (6,15,29,37). However, the number of studies in the field concerning psychometric properties of home-based teleneuropsychological

assessment, which is particularly important in terms of improving accessibility, is still rather limited. Furthermore, conducting studies and preparing protocols related to the hybrid model, which is viewed as a third application model and is a mixture of face-to-face assessments and technology-based assessments (such as computer-based tests), will be meaningful for clinical practices (48). Lastly, for Türkiye, it is crucial to address the gaps in the legal regulations related to telemedicine, including teleneuropsychology. For instance, issues related to the risk of ending up with incorrect or incomplete diagnoses and treatments due to lack of clinical observation, ownership of responsibility related to the potential damages due to this risk, ensuring data security, and addressing the gaps and uncertainties related to protecting patient privacy need to be legally resolved.

Acknowledgment: We would like to thank Merve Mutafoğlu Sarıbay, Aysu Işık and Selin Kılıçkaya for their contributions.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept- EY; Design- EY, ESB, ŞAK, İHG; Supervision- EY, ŞAK; Resource- EY; Materials- ŞAK, İHG; Data Collection and/or Processing- ŞAK, EY; Analysis and/or Interpretation- ESB, EY, ŞAK; Literature Search- EY, ESB; Writing-EY, ESB, ŞAK, HG; Critical Reviews- HG, EY, ESB.

Conflict of Interest: The authors declared that there is no conflict of interest.

Financial Disclosure: The study on the subject discussed in this article was supported by TÜBİTAK SOBAG project no. 121K261.

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