A teleneuropsychological battery for assessing older Panamanian adults: Protocol for a Pilot Feasibility Study

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Table of Contents

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Abstract

Background: Teleneuropsychology (TNP) has evidenced to be a crucial tool in the assessment and treatment of individuals with limited access to in-person health services. Studies in Latin America are scarce and there is a pressing need for studies that test the feasibility of TNP and contribute to the development of tools, models, and validations, and the establishment of normative data for the diverse populations of the region.

Objective: Conduct a pilot study to test feasibility and generate normative data for a Teleneuropsychology protocol in a Panamanian sample.

Methods: This is a cross-sectional, descriptive, community-based study derived from the Development and Validation of Teleneuropsychology Normative Data for Older Adults in Florida (FLOAT study). The study's final sample will include 150 participants (50 years and older). Participants will first undergo an initial screening to determine their eligibility and will be included if they have a basic understanding of and access to technological devices such as telephones, tablets, or computers, are free of cognitive impairment and/or serious health conditions and provide informed consent. Moreover, participants complete two questionnaires: an adapted Spanish version of the Telephone Interview for Cognitive Status of Memory (TICS-M) and the National Alzheimer's Coordinating Center (NACC) Health Questionnaire to determine if they can continue in the study. Participants who are eligible will be assessed with a TNP cognitive battery and answer questionnaires via a REDCap link.

Results: To date, 67 participants ?50 years of age (M=62.2, SD=7.6) have been assessed with questionnaires and a complete cognitive test battery. Sociodemographic and clinical characteristics show participants on average had 16.7 years (SD = 1.9) of formal education. Participants showed a high degree of functional independence in performing basic and instrumental activities of daily living and had 1.5 symptoms of depression (SD = 1.8). Regarding the teleneuropsychological tests, when divided by sex, participants showed no significant differences in most tests, except for the MINT naming test, where a higher score was observed in males than females ($p < .001$). A similar pattern was observed in the verbal fluency test, with males performing better than females ($p = .032$). A satisfaction questionnaire revealed most participants were satisfied (33.8%) or very satisfied (60%) with the teleneuropsychological assessment, and most participants would recommend this study to others.

Conclusions: So far, the present study has proven feasible, yet, augmenting the number of participants is necessary to be able to create normative data. This study will be the first in the country and the Central American region to explore and establish teleneuropsychology as a new assessment method, specifically in elderly populations.

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Abstract

Background: Teleneuropsychology (TNP) has evidenced to be a crucial tool in the assessment and treatment of individuals with limited access to in-person health services. Studies in Latin America are scarce and there is a pressing need for studies that test the feasibility of TNP and contribute to the development of tools, models, and validations, and the establishment of normative data for the diverse populations of the region.

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Results: As of November 11th, 2024, 67 participants ≥50 years of age (M=62.2, SD=7.6) have been assessed with questionnaires and a complete cognitive test battery. Sociodemographic and clinical characteristics show participants on average had 16.7 years (*SD* = 1.9) of formal education. Regarding the teleneuropsychological tests, no significant differences were found in the scores of most of the tests applied, except for the MINT, where a higher score was observed in males (M=31.3, SD= 0.7) than in females (M=29.7, SD= 1.8) ($p < .001$). A similar pattern was observed in the verbal fluency test, with males (M=63.8, SD=11.9) performing better than females (M=56.3, SD=11.4) ($p=.032$). Moreover, participants were divided into three age groups, 51-60, 61-69, 70 and older. No significant differences were observed among groups except in the Wisconsin Sorting Card Test, where younger participants, age range 51-60 (M=46.0, SD=9.3) and age range 61-69 (M=46.0, SD= 12.5) performed better than the older group (M=28.7, SD=14.5) ($p=.020$). A satisfaction questionnaire revealed most participants were satisfied (33.8%) or very satisfied (60%) with the teleneuropsychological assessment, and most participants would recommend this study to others.

Conclusions: So far, the present study has proven feasible, yet, augmenting the number of participants is necessary to be able to create normative data. This study will be the first in the country and the Central American region to explore and establish teleneuropsychology as a new assessment method, specifically in elderly populations.

Introduction

Teleneuropsychology (TNP) refers to the use of audiovisual technologies for remote neuropsychological assessments and interventions [1]. Specialty psychological services, namely neuropsychological assessments, seek to integrate digital tools into conventional practice, combining traditional in-person measures for rich clinical observations with novel digital or remote assessments that allow for more precise quantification of behavioral patterns [2]. TNP require the use of various tests and tools to evaluate a person's current cognitive and emotional status. This service usually requires patients to visit assessment sites and undergo clinical interviews and neuropsychological testing. Nevertheless, health emergencies like the COVID-19 pandemic hindered in-person visits prompting mental health professionals to adopt remote evaluations, or teleneuropsychological assessments as an alternate method. The Inter Organization Practice Committee (IOPC) created new guidelines for the practice of TNP during the pandemic [3, 4]. In Latin America, recommendations on the use of TNP emerged during the pandemic [3]. However, tele-neuropsychology did not arise solely as a response to health emergencies. Prior to COVID-19, guidelines for remote testing had been created by the American Psychological Association and Joint Task Force for the Development of Teleneuropsychology Guidelines for Psychologists [5]. Moreover, historically, studies have explored the validity and feasibility of remote care, initially through telephone and later through video conferences.

Teleneuropsychology: how it came to be and its development before the COVID-19 pandemic

TNP's origins date back to the 1980s, when telephones were used for patient follow-up and cognitive health assessments. By then, widespread telephone use in U.S. households facilitated telephonic data collection, particularly in primary care for consultations and surveys. In the 1990s, telephones were used for follow-ups with patients and screenings to detect dementia in older adults [6] as they function as a cost-effective alternative to in-person surveys [7]. In this period, there was an initial exploration of the feasibility of videoconferencing for cognitive evaluations in older adults [8], [9] and an ongoing development and validation of remote tests [10–19]. Telephone screening tools, such as the Telephone Interview for Cognitive Status and the Mini-Mental Status Examination, offer benefits like rapid administration and cost-effectiveness, making them suitable for large-scale epidemiological studies [20]. These tools can also reduce dropout rates in longitudinal studies and address geographical limitations [21]. Older adults, who may have mobility issues or reduced motivation, often respond well to telephone assessments, enabling "cognitive triage" and follow-ups in hard-to-reach populations [22]. However, the effectiveness of telephone assessments largely depends on the design of the screening instruments [23]. In this regard, videoconference presents certain limitations such as the inability to evaluate praxis or visuospatial abilities [24], lack of visual stimuli and the examiner's inability to directly observe behavior in an uncontrolled environment [25], as well as communication issues due to hearing loss or cognitive decline also posed challenges [26].

Since the early 21st century, research has explored the feasibility of teleneuropsychological assessments. Studies have shown no significant performance differences between videoconference and face-to-face assessments, demonstrating its feasibility and potential utility [27–30]. Furthermore, teleneuropsychology has not hindered clinical intervention or rapport-building [31, 32]. Diagnostic agreement between on-site and videoconference screenings for neurocognitive disorders has also been confirmed [33]. Acceptability [34] and satisfaction [35] with teleneuropsychology have been documented, including assessments designed for use in Latin populations [36].

State of teleneuropsycholgy during COVID-19: uses, validation, and research

Before the pandemic, a survey revealed that about one-fourth of professionals, primarily from the U.S., used TNP for clinical interviews and interventions [37]. This highlighted the underutilization of teleneuropsychology, which was largely due to lack of reimbursement from Medicare and private insurance [38]. Challenges such as limited access to technology, inability to perform hands-on assessments, and reduced behavioral observation opportunities also hindered its adoption [39]. However, lockdowns increased the need for recommendations and research, leading to greater utilization of TNP among practitioners [40–43]. Research during the COVID-19 pandemic underscored the necessity for further investigation into TNP and its limitations. Individuals with lower incomes often lacked access to necessary technology [44, 45]. Additionally, participants' computer literacy skills were frequently inadequate, and there was a scarcity of research on teleneuropsychology's application in home healthcare [46–49].

Research in TNP, especially concerning culturally diverse populations, has progressed following the declaration of the end of the COVID-19 pandemic [50–52]. Notably, neuropsychologists have reported significant use of this work method [53]. Additionally, new tools like the Tele-Global Examination of Mental State (Tele-GEMS) [54] and Tele Executive Function (TeleFE) for children [55] have shown promising results.

Teleneuropsychology in Latin America: research and practice

Until 2021, no studies on teleneuropsychology had been reported in Latin America [39]. However, from 2021 to date, eight studies have been documented regarding the use of TNP in four countries in the region. Most of the studies are descriptive, and only one is a randomized controlled trial. In 38% of the studies a survey was satisfaction survey was included. In 50% teleneuropsychology was used to evaluate participants, and in one study telerehabilitation was performed. Results indicated good acceptance of teleneuropsychology as an assessment or rehabilitation modality by both participants and professionals [49, 56, 57]. Key benefits included reducing the stress of travelling to evaluation sites, increased accessibility to remote areas, increased comfort of home assessments [44, 58], continued access during social distancing and reduced COVID-19 risk [57]. Moreover, challenges noted by practitioners included patients' unfamiliarity with technology, lack of environmental control and insufficient access to technological resources including internet connectivity [45].
These studies represent a significant initial progress in Latin America, revealing insights into the experiences of neuropsychology professionals in the region. Although Mexico and Argentina are middle-income countries, they face findings and challenges like those seen in developed nations. Moreover, proposals for clinically applicable models are beginning to emerge in Latin America [59].

The objective of this study is to conduct a pilot study to test feasibility and generate normative data for a Teleneuropsychology protocol in a Panamanian sample.

Methods

Participants

The protocol of this study was adapted from the Development and Validation of

TeleNeuropsychology Normative Data for Older Adults in Florida (FLOAT), a study being conducted at the University of Florida with the aim of validating a battery in a healthy sample of older adults with low risk of developing Alzheimer’s disease and other related dementias (ADRD). The current study is cross-sectional, descriptive, and community based. We aim to recruit 150 participants, 50 years of age or older, who reside in Panamá. We present preliminary data for 67 participants who have been recruited and assessed as of November 11th, 2024. Details of participants invited to participate, recruited, and assessed are shown in Figure 1. The study protocol was approved by the Research Bioethics Committee of Universidad Santa María La Antigua (CBI-USMA) (2022-P004).

Eligibility criteria

Participants are included in the study if they meet the following criteria: 1) are 50 or more years of age at the time of enrolment; 2) have a basic understanding and control of technological devices; 3) have access to a phone, tablet or computer; 4) have signed informed consent; 5) do not present any conditions that limit or prevent them from having a neuropsychological evaluation (i.e., blindness, analphabetism, severe physical limitations); 6) are available to assist to all the program visits included in the study; 7) the absence of cognitive impairment at the time of enrollment. Participants are excluded from the study if they have any of the following: 1) a diagnosis of ADRD or other neurological disorders that affect cognitive functioning; 2) a history or diagnosis of a severe psychiatric disease (i.e., schizophrenia); 3) evidence of cognitive impairment (TICS-M <31); 4) No access to internet; 5) No access to a smartphone with web camera for video conference; 6) ongoing participation in another clinical study or the intention to participate in another study.

Recruitment

Potential participants are recruited from the community in Panama through social media advertisements, flyers in community centers, and newspaper announcements. Individuals living outside the city are also encouraged to participate due to the availability of remote testing. The research team, which includes the principal investigator, research assistants, and trained psychology students, engage with interested individuals to facilitate recruitment. Participant recruitment process is displayed in Figure 2.

Procedure

Participants undergo an initial screening to determine their eligibility. Those who meet the inclusion criteria and agree to participate will provide telephone-informed consent. Following this, participants complete two questionnaires: an adapted Spanish version of the Telephone Interview for Cognitive Status of Memory (TICS-M) and the National Alzheimer’s Coordinating Center (NACC) Health Questionnaire. These assessments help identify any underlying neurological diseases or uncontrolled medical conditions that may impact cognition, such as depression or bipolar disorder. The screening aims to (1) confirm the participant does not have cognitive impairment (e.g., MCI or dementia) and (2) ensure they have the cognitive capacity to provide informed consent. Participants scoring ≤ 31, indicating mild cognitive impairment or dementia, are excluded from the study. Those who do not meet the eligibility criteria are thanked for their time, and the assessment is discontinued.

Eligible participants receive a link to complete the questionnaires and surveys via email using the Research Electronic Data Capture (REDCap ®) platform, an online platform designed for data collection and storage [60]. This process takes approximately 30 minutes. Later, the research team schedules a two-hour block for the teleneuropsychological assessment. A team member assists participants in setting up the videoconferencing technology. Prior to beginning the study, research staff reviews the informed consent document with the participant and address any questions.

REDCap is utilized to capture and store participant data, while zoom facilitates the administration of neurocognitive tests. The screen-sharing feature is employed to display test stimuli. For tasks requiring a scored motor component (e.g., figure drawing), participants are asked to hold their drawings up to the camera, and a screenshot is taken for later scoring. These screenshots do not include any identifying information about the participants. Captured images are stored in the participant's REDCap dataset for future analysis. During the assessment, two computers are utilized: a laptop and a touchscreen device, both of which project visual stimuli via the screen-sharing function. These stimuli are displayed in PowerPoint, and data collection is conducted in REDCap throughout the assessment.

Measures

Following the FLOAT protocol, this study utilizes, an open-access battery in Spanish that is part of the Uniform Data Set version 3 (UDSv3), comprising longitudinal data collected since 2005 at the NIA-funded Alzheimer's Disease Research Centers (ADRCs) (National Alzheimer's Coordinating Center, 2023). All measures in this study have been adapted for use with REDCap. Additionally, several questionnaires, including the Health History, Functional Activity Index (FAI), Geriatric Depression Scale (GDS), and Demographic Information, have been modified to be completed directly by participants.

The evaluation process lasts approximately three hours, which includes 30 minutes for informed consent and screening measures, 30 minutes for participant-completed questionnaires via the REDCap platform, and approximately two hours for tele-neuropsychological testing.

Screening measures

1) Telephone Interview for Cognitive Status of Memory (TICS-M): A Spanish version of this screening measure is used to assess the presence of mild cognitive impairment (MCI) [61]. We modified certain items from the questionnaire to better fit the Panamanian context, such as changing "Who is the president of the United States?" to "Who is the president of Panama?"
2) NACC Health History: This measure assesses the participant's general health history to identify potential neurodegenerative diseases or other risk factors that may exclude them from participation in the research [62].

Questionnaires

These questionnaires were obtained in the Spanish versions. Participants fill out these questionnaires online using a REDCap link provided by the study team.

1) NACC-Demographics: The demographic NACC questionnaire has been modified to better suit the Panamanian population by adapting relevant questions and removing those that are not applicable, such as inquiries about the last digits of the zip code or the Alzheimer's Disease Research Center (ADRC) [62].
2) Geriatric Depression Scale (GDS): The Spanish version of the Geriatric Depression Scale (GDS) is included to assess symptoms of depression. This questionnaire consists of 30 yes/no questions, which participants complete via a REDCap form. Participants scoring above 20 on the GDS

prompt the study team to contact them to inquire about suicidal ideation [63].

3) Functional Activity Index: This questionnaire assesses the individual's functionality in activities of daily living, which may decrease in the presence of a neurodegenerative process [62].

Teleneuropsychological Tests

1) Montreal Cognitive Assessment (MoCa): An adapted Spanish version of the MoCa is used. The MOCA is a cognitive screening tool that measures different domains: visuospatial, naming, verbal memory, working memory, attention, language, abstraction, and orientation [64].
2) Craft Story: This test assesses verbal memory through immediate and long-term recall using a semantically related story. Participants first listen to the story and, following a 20-minute interval, are asked to recount what they remember from the story, maintaining the original phrasing [65].
3) Rey Verbal Learning Test (RAVLT): Participants must learn a list of 15 words through continuous repetition by the evaluator. After five trials, an interference list is presented. After a 20–30-minute timespan, participants try to recall the original list. These tests assess immediate and delayed memory recall, as well as recognition of the previously learned words [66].
4) Benson Complex Figure: Participants are required to copy a complex figure, including all its elements. Ten minutes later, they are asked to recall the copied figure and recognize the original one. This test measures visual memory and visuoconstruction skills [67].
5) Multilingual Naming Test (MINT): This test measures naming ability. Participants observe a figure and are asked to name it. If they struggle to name the figure, the evaluator provides semantic or phonemic cues to assist them [68].
6) Digit Span Test: This test is used to assess attention and working memory. Participants repeat a sequence of numbers in the order presented (forward) and then in reverse order (backward). The difficulty increases as they respond correctly, continuing until they can no longer repeat the numbers accurately [69].
7) Verbal Fluency: In this timed task, participants generate as many words as possible that start with a specific letter (F, A, S, or M). Names, numbers, repeated words, and words not starting with the specified letter are not counted [70].
8) Category Fluency: This timed task requires participants to generate as many words as possible from a specific category (such as animals, vegetables, or fruits). Repeated words only count the first time they are mentioned [70].
9) Wisconsin Card Sorting Test- 64 (WCST-64): This test measures executive functions using a computer version. The evaluator shares the screen with the participant, allowing them to control it. If the participant cannot control the screen, the evaluator will ask them to indicate choices verbally (e.g., “1” for a red triangle, “2” for two green stars, etc.) [71].
10) Boston Naming Test (BNT): Using a 15-item version adapted from the Mayo Older Americans Normative Studies (MOANS), participants name pictures displayed in a PowerPoint presentation. If they cannot name a figure, the evaluator provides semantic or phonemic cues [72].
11) Symbol Digit Modality Test (SDMT) - Oral Version**:** This is the oral version of the SDMT, where a PowerPoint slide is shared with the participant, and the evaluator records responses on REDCap as the task is performed. This test measures speeded information processing [73].
12) Word Accentuation Test (WAT) Chicago: This list-reading test assesses premorbid intelligence. Participants read a list of words, trying to place the accent where it belongs [74].

Statistical analyses

Neuropsychological test results will be analyzed using multivariate statistical methods. We will perform initial data analyses with chi-square and ANOVA tests to observe distribution across age groups or other groups of interest. We will obtain raw scores of each test as well as composites of cognitive domains to make further analyses per test and per cognitive domain. Multivariable regression analyses will be performed to assess linear relationships between age, years of education or other (i.e., income) variables and cognition. Missing data will be handled depending on the most appropriate method.

Ethical considerations

Confidentiality

All data collected is saved in a password-protected database. Only authorized research personnel have access to this database. If a participant wishes to no longer be part of the study, the information collected before its retirement will still be analyzed with the rest of the data. Data collected on REDCap is identified with a specific number to protect the identity of the participant.

Harm

Some estimated harms that could be caused by this type of evaluations include fatigue, stress, or anxiety while either responding to the questionnaires or performing the neuropsychological tests. However, we expect minimal harm to our participants. If the participant needs it, the evaluation is rescheduled. Participants are informed that they are free to withdraw from the research study at any time.

Data Management

All data, including consent, is obtained, and added to a REDCap database that has all the measures obtained in this study. To ensure high-data quality collection, scoring of the tests is reviewed by 2 different evaluators at the end of the testing.

Dissemination Policy

Results from this research will be published, shared, and presented at national and international conferences, science events and high impact journals. At the end of the study, participants will be given a summary of their results that will give them an insight of their cognitive status. The report will be divided in different cognitive domains, including “below average”, “average”, “above average” to identify the participant’s cognitive level when compared with other peers of the same age range, sex, and education.

Preliminary results

General characteristics of the sample

The demographic and clinical characteristics of the sample are summarized in Table 1. Participants were mostly female (79.1%) and were on average 62.2 years old (*SD*=7.6). Participants had 16.7 years (*SD*=1.9) of formal education. Most participants have a partner (65.7%). Participants reported few cardiovascular, cerebrovascular, and psychiatric illnesses. Nevertheless, the most common chronic illness is hypertension (32.8%), followed by hypercholesterolemia (28.4%). Most participants identify with white race (46.3%). However, the race variable must be viewed carefully in

Panamanian population since it is not commonly assessed in this population and is more difficult to determine compared to other countries such as the United States of America. Participants showed a high degree of functional independence in performing basic and instrumental activities of daily living. On average participants had 1.5 symptoms of depression (*SD*=1.8).

Table 1. *Demographic and clinical characteristics of study participants*

Variable	Total *n* (%) / *M* (*SD*) (*n* = 67)
Age (Years)	62.2 (7.6)
Sex, Female (n, %)	53 (79.1%)
Race (n, %)	
White	31 (46.3%)
African American or Black	11 (16.4%)
Indian American	2 (3.0%)
Asian	1 (1.5%)
Unknown	2 (3.0%)
Other	20 (29.9%)
Marital Status	
Partnered	44 (65.7%)
Not partnered	23 (34.3%)
Education (Years)	16.7 (1.9)
Years smoking	15.3 (12.4)
Age quit smoking	36.7
Diabetes (% yes)	6 (9.0%)
Hypertension (% yes)	22 (32.8%)
Hypercholesterolemia (% yes)	19 (28.4%)
Thyroid disease (% yes)	13 (19.4%)
Arthritis (% yes)	9 (13.4 %)
No. of cardiovascular Disease	0.25 (0.8)
No. of cerebrovascular illnesses	0.15 (0.5)
No. of medical conditions	1.1 (1.0)
No. of sleep related illnesses	0.33 (0.6)
No. of psychiatric diseases	0.33 (0.8)
Depression (% yes)	11 (16.4%)
Anxiety (% yes)	7 (10.4%)
Geriatric Depression Symptoms	1.5 (1.8)
Functionality Index	0.5 (0.8)

Preliminary cognitive tests results

Results for cognitive tests for the total sample and divided by sex is shown in Table 2. Regarding the teleneuropsychological tests, no significant differences were found in the scores of most of the tests applied, except for the MINT, where a higher score was observed in males (M=31.3, SD= 0.7) than in females (M=29.7, SD= 1.8) (p < .001). A similar pattern was observed in the verbal fluency test, with males (M=63.8, SD=11.9) performing better than females (M=56.3, SD=11.4) (p=.032). Moreover, participants were divided into three age groups, 51-60, 61-69, 70 and older. No significant differences were observed among groups except in the Wisconsin Sorting Card Test, where younger participants, age range 51-60 (M=46.0, SD=9.3) and age range 61-69 (M=46.0, SD= 12.5) performed better than the older group (M=28.7, SD=14.5) (Table 3).

Table 2. *Cognitive tests for total sample, men, and women*

Cognitive Test	Total *n* (%) / *M* (*SD*) (*n* = 67)	Min	Max	Male *n* (%) / *M* (*SD*) (*n* = 14)	Female *n* (%) / *M* (*SD*) (*n* = 53)	*P value*
TICS-M	36.4 (2.5)	32	43	36.29 (2.7)	36.42 (2.5)	*p = .87*
MOCA	25.8 (2.3)	20	30	26.6 (1.9)	25.6 (2.3)	*p = .17*
RAVLT immediate 1	48.7 (8.4)	28	73	46.8 (6.8)	49.2 (8.7)	*p = .34*
RAVLT immediate 2	10.3 (2.9)	0	15	9.7 (3.7)	10.4 (2.7)	*p = .42*
Benson Complex Figure Immediate	12.6 (2.3)	7	16	13.1 (2.1)	12.4 (2.3)	*p = .35*
OTMTA correct	24.9 (0.6)	20	25	25.0 (0.0)	24.9 (0.7)	*p = .61*
OTMTA time	9.8 (3.3)	4	27	10.0 (3.2)	9.8 (3.4)	*p = .89*
OTMTB correct	23.8 (2.7)	8	25	22.4 (5.0)	24.2 (1.5)	*p = .21*
OTMTB time	40.4 (27.8)	14	166	33.9 (24.3)	42.2 (28.6)	*p = .33*
Digit Span Test forward	6.9 (1.8)	3	11	7.1 (2.3)	6.9 (1.6)	*p = .70*
Digit Span Test backward	6.3 (1.8)	2	11	6.6 (1.5)	6.2 (1.9)	*p = .53*
Benson Complex Figure Delayed 1	10.4 (2.7)	2	15	10.9 (2.2)	10.3 (2.9)	*p = .41*
Benson Complex Figure Delayed 2	1.0 (0.2)	0	1	0.9 (0.3)	1.0 (0.2)	*p = .59*
RAVLT Delayed 1	10.2 (3.6)	0	15	10.5 (4.3)	10.1 (3.4)	*p = .70*
RAVLT Delayed 2	14.5 (1.0)	10	15	14.7 (0.5)	14.4 (1.1)	*p = .28*
MINT	30.1 (1.8)	25	32	31.3 (0.7)	29.7 (1.8)	*p< .001*
Craft Story immediate 1	21.7 (5.3)	10	34	22.6 (5.3)	21.5 (5.3)	*p = .47*
Craft Story immediate 2	17.2 (2.8)	10	24	17.3 (2.5)	17.2 (2.9)	*p = .87*
Wisconsin Sorting Card Test	43.2 (12.7)	15	59	40.5 (10.9)	44.1 (13.2)	*p = .42*
Symbol Digit Modality Test	40.1 (12.0)	4	69	36.9 (10.1)	40.9 (12.5)	*p = .27*
Craft Story delayed 1	19.5 (5.6)	8	31	21.3 (4.0)	19.0 (5.9)	*p = .17*
Craft Story delayed 2	16.0 (3.2)	8	21	16.6 (2.4)	15.9 (3.3)	*p = .42*
Verbal Fluency	57.8 (11.8)	33	83	63.8 (11.9)	56.3 (11.4)	*p = .03*
Category Fluency	51.0 (8.9)	33	73	53.1 (6.9)	50.4 (9.3)	*p = .32*
Boston Naming Test	12.3 (1.5)	8	15	12.4 (1.2)	12.3 (1.6)	*p = .87*
Word Accentuation Test	41. 0 (6.6)	24	52	43.1 (7.0)	40.5 (6.5)	*p = .19*

Note: TICS-M: Telephone Interview for Cognitive Status of Memory; MOCA: Montreal Cognitive Assessment; RAVLT: Rey Auditory Verbal Learning Test; OTMT: Oral Trail Making Test; MINT: Multilingual Naming Test

Table 3. *Cognitive tests divided by age group*

Cognitive Test	Age group 51-59 *n* (%) / *M* (*SD*) (*n* = 29)	Age group 60-69 *n* (%) / *M* (*SD*) (*n* = 26)	Age group 70+ *n (%) / M (SD) (n =11)*	*P value*
TICS-M	36.7 (2.6)	36.0 (2.3)	36.0 (2.4)	*p = .51*

MOCA	26.2 (2.5)	25.9 (1.9)	24.6 (2.3)	*p = .41*
RAVLT immediate 1	48.7 (9.5)	48.2 (7.0)	50.2 (9.2)	*p = .57*
RAVLT immediate 2	10.2 (3.6)	10.2 (2.5)	10.6 (1.8)	*p = .81*
Benson Complex Figure Immediate	12.6 (2.2)	12.9 (2.4)	11.6 (2.1)	*p = .43*
OTMTA correct	25.0 (0.0)	24.8 (1.0)	25 (0.0)	*p = .48*
OTMTA time	9.5 (3.9)	10.0 (2.8)	10.5 (3.1)	*p = .69*
OTMTB correct	23.8 (1.9)	23.6 (3.7)	24.3 (1.3)	*p = .59*
OTMTB time	40.3 (23.9)	39.2 (24.3)	45.7 (44.1)	*p = .74*
Digit Span Test forward	7.0 (2.0)	6.6 (1.8)	7.5 (0.8)	*p = .15*
Digit Span Test backward	6.2 (2.0)	6.3 (1.6)	6.6 (1.8)	*p = .73*
Benson Complex Figure Delayed 1	10.6 (3.1)	10.5 (2.4)	9.6 (2.5)	*p = .65*
Benson Complex Figure Delayed 2	1.0 (0.0)	1.0 (0.2)	0.8 (0.4)	*p = .16*
RAVLT Delayed 1	10.2 (4.1)	10.1 (3.5)	10.4 (2.5)	*p = .78*
RAVLT Delayed 2	14.3 (1.2)	14.7 (0.7)	14.4 (0.8)	*p = .45*
MINT	30.2 (1.4)	30.2 (1.9)	29.2 (2.1)	*p = .25*
Craft Story immediate 1	21.1 (5.6)	21.7 (4.8)	23.5 (5.9)	*p = .42*
Craft Story immediate 2	16.9 (2.9)	17.8 (2.8)	16.7 (2.5)	*p = .63*
Wisconsin Sorting Card Test	46.0 (9.3)	46.0 (12.5)	28.7 (14.5)	*p = .02*
Symbol Digit Modality Test	39.4 (12.5)	43.6 (11.1)	32.9 (10.7)	*p = .35*
Craft Story delayed 1	18.5 (5.3)	19.8 (5.5)	21.3 (6.7)	*p = .26*
Craft Story delayed 2	15.7 (3.3)	16.9 (2.8)	15.5 (3.3)	*p = .55*
Verbal Fluency	58.0 (12.0)	58.8 (11.3)	53.6 (12.0)	*p = .89*
Category Fluency	52.2 (7.3)	50.7 (9.5)	47.2 (10.4)	*p = .36*
Boston Naming Test	12.7 (1.4)	12.2 (1.5)	11.6 (1.5)	*p = .17*
Word Accentuation Test	40.1 (6.6)	41.9 (6.6)	41.7 (7.3)	*p = .53*

Note: TICS-M: Telephone Interview for Cognitive Status of Memory; MOCA: Montreal Cognitive Assessment; RAVLT: Rey Auditory Verbal Learning Test; OTMT: Oral Trail Making Test; MINT: Multilingual Naming Test

Table 4 shows the frequencies and percentages of the results of the Teleneuropsychological Assessment Satisfaction Scale. Most participants were very satisfied (60%) with the teleneuropsychological assessment, while high levels of satisfaction were found with other elements of the assessment such as the use of the zoom platform (63.5%), the evaluator (87.7%) or with the REDCap platform (50.8%). All participants reported instructions were clear. Most participants were satisfied with being able to do the evaluation from home (75.4%). Two thirds of participants reported they were able to use electronic equipment such as computers, phones, or tablets (67.7%). Most participants would recommend a teleneuropsychological assessment to others.

Table 4. *Satisfaction with the teleneuropsychological assessment*

Select your degree of satisfaction with the teleneuropsychological assessment (*n = 65)*	*n (%) / M (DE)*
Very dissatisfied	1 (1.5%)
Dissatisfied	0 (0.0%)
Neutral	3 (4.6%)
Satisfied	22 (33.8%)
Very Satisfied	39 (60.0%)
Were you satisfied with the use of Zoom?	
Very dissatisfied	0 (0.0%)
Dissatisfied	0 (0.0%)
Neutral	2 (3.1%)
Satisfied	16 (24.6%)
Very Satisfied	47 (63.5%)

Were you satisfied with the evaluator´s treatment?	
Very dissatisfied	0 (0.0%)
Dissatisfied	1 (1.5%)
Neutral	0 (0.0%)
Satisfied	7 (10.8%)
Very Satisfied	57 (87.7%)
Were you satisfied with the REDCap Platform?	
Very dissatisfied	1 (1.4%)
Dissatisfied	0 (0.0%)
Neutral	5 (7.7%)
Satisfied	26 (40.0%)
Very Satisfied	33 (50.8%)
I was able to easily understand the instructions given to me to complete the tests	
Agree	26 (40.0%)
Strongly agree	39 (60.0%)
Aspects of the assessment that you liked	
Being able to do it from home or a place near home	49 (75.4%)
Being able to use computers/cellphone/Tablet to answer the tests	44 (67.7%)
The communication with the evaluators	41 (63.1%)
The attention given to me by the evaluators	46 (70.8%)
Other (Feeling competent, helping the research, wished to know more, etc)	7 (10.8%)
Aspects of the assessment that you had difficulties with	
With internet connection	8 (12.3%)
With the space where I was during the assessment	8 (12.3%)
With the computer/cellphone/Tablet that I used during the assessment	5 (7.7%)
With the evaluatorsCon los evaluadores	1 (1.5%)
Other	12 (18.5%)
I had no difficulties	53 (81.5%)
Adequate time for the assessment	
Yes	59 (90.8%)
No	6 (9.2%)
Reasons why time wasn’t adequate	
I recommend dividing the assessment	1 (1.5%)
Application of the tests took too much time	1 (1.5%)
Assessment time is too long	4 (6.2%)
What would you change of the assessment?	
The initial contact with the investigators (when I was called to participate)	2 (3.1%)
REDCap Platform	1 (1.5%)

The questionnaires used	10 (15.4%)
The test used	1 (1.5%)
The time used for the assessment	10 (15.4%)
I wouldn´t change anything	41 (63.1%)
What would you change?	
Less pauses or breaks	1 (1.5%)
Improve the redaction of the questionnaires	8 (12.3%)
Shorter assessment or questionnaires	7 (10.8%)
Time between the assessment and the application of the questionnaires	1 (1.5%)
Better explanation of the study	2 (3.1%)
Difficulties with their own capabilities	2 (3.1%)
Would change something, but does not explain	3 (4.6%)
Would recommend a TNP evaluation	
Strongly disagree	0 (0.0%)
Disagreed	1 (1.5%)
Neutral	3 (4.6%)
Slightly agree	3 (4.6%)
Agree	21 (32.3%)
Strongly agree	37 (56.9%)

Preliminary satisfaction results

Although most of the sample reported no difficulties at all (81.5%), main limitations that were stated by participants were: internet connection (12.3%), space in which the assessment took place (12.3%) and electronic equipment used (7.7%). Other barriers (18.5%) included the long duration of the assessment, confusing wording in questionnaires, problems with sound, interruptions, difficulties with the assessment materials, problems with the Zoom platform, availability for the assessment, lack of light and complaints regarding their own abilities.

Discussion

Principal Results

This paper presents a pilot study designed to assess the feasibility of conducting teleneuropsychological cognitive assessments in adults aged 50 and older. TNP is a technology-based practice that includes collecting patient data using multiple assessment modalities. So far, we have established that this type of evaluation is feasible for a sample of elderly participants in Panama. We have successfully assessed 67 participants with a complete TNP evaluation. Our results indicate that our sample is comparable to those in other studies in terms of age [75, 76], education level [30, 77], and the distribution of men and women [38]. Preliminary cognitive results show that there were no significant differences between men and women for most cognitive tests except for two tests, MINT and verbal fluency. These results contrast with findings in other studies, which typically report that women perform better than men on remote cognitive tests [78, 79]. There are few studies regarding TNP where performance is analyzed comparing men and women, most studies compare among different assessment modalities (i.e. remote versus hybrid or versus face-to face; in-clinic versus in-home) [80] age groups [81], healthy controls versus individuals with cognitive or health conditions [82]. Correspondingly, when comparing between age groups, no significant differences were evident except for Wisconsin Sorting Card Test, a test to measure certain aspects of executive function such as flexibility and cognitive shifting. Studies suggest that these functions tend to decline with age [83], [84].

Moreover, feasibility was demonstrated through the successful use of various technological platforms in the assessments, including REDCap and Zoom. This approach to teleneuropsychological assessments has been recommended in other studies [43] and aligns with guidelines established before and during the COVID-19 pandemic [1, 83]. To date, very few studies in Panama have used REDCap to capture and store clinical data, nevertheless, this is the first time it is used for neuropsychological assessments, making this an unprecedented study. REDCap has been widely used and recommended for teleneuropsychology studies across various regions worldwide [3, 84], as data can only be accessed with a password and server administrator permissions, making the platform ideal for securely storing the collected information [87]. Likewise, using Zoom as the platform for the assessment is a notable strength, as it has been effectively utilized in other similar studies [48, 86].

Additionally, participant satisfaction was assessed, revealing that most respondents were highly satisfied with the remote assessment. This aligns with findings from previous studies on participant satisfaction [34, 35, 40, 87]. Key positive aspects highlighted by participants included the use of electronic equipment, the convenience of conducting assessments from home, and the quality of interaction and communication with evaluators. These findings reinforce the strengths of teleneuropsychology identified in another research [39].

Limitations

Participants reported difficulties primarily related to electronic equipment, internet connectivity, and the environment in which the assessment took place. These limitations are common challenges associated with teleneuropsychology [88, 89], and since participants completed the assessment at home, these factors were beyond the assessor's control. The use of REDCap presents both strengths and limitations. On the one hand, this platform ensures secure and confidential storage of test and questionnaire data, as it is only accessible to those connected to the research institution's server. On the other hand, because the server hosting REDCap is owned by the institution, both the researcher and the participant must have access to the server to utilize the platform.

Other limitations include recruitment which was conducted via convenience sampling which hinders the inclusion of a diverse sample. This resulted in participants with a high level of education and a medium to high socioeconomic level that are not representative of the population.

Strengths

The study's strengths include the innovative TNP assessment format, which involved both the participant and assessor being at home—creating a TNP 'home-to-home' format, an approach that has been validated, but not extensively studied [40, 46, 58, 90, 91]. This is of particular interest given that the use of TNP home-to-home neuropsychological testing by mental health professionals has been reported in the Latin American region, yet no specific studies documenting this modality have been published to date [57], making this study one of the few to explore this method.

The application of the assessment battery enabled the collection of specific data from the Panamanian population, paving the way for the development of normative data for tests administered in a distance format. This aims to address a significant limitation in the region, where standardized tests have not been adapted to the populations of these countries [92–95].

While some participants reported challenges related to connection issues, the assessment environment, and the equipment used, it's important to note that these difficulties were experienced by only a minority of the sample. Additionally, specific issues related to the questionnaires emerged; participants noted that the wording and timing of the questions were not favorable. In contrast, the overall timing of the evaluation itself was well received by participants.

Conclusions

Teleneuropsychology has gained ground in the field of psychology, offering new spaces and opportunities for professionals, patients, and participants. Ongoing research is essential to bring clarity to the clinical practice of those using these alternatives. Drawing on lessons learned before, during and after the pandemic, many professionals have adopted models that combine elements of remote and traditional face-to-face care, giving rise to hybrid neuropsychology [98]. In Latin America, further research is essential, particularly studies aimed at developing instruments, models, validations, and establishing normative data for diverse populations in the region. Although initial progress is underway, the present study will be the first to explore and establish teleneuropsychology as a new assessment method, specifically in elderly populations in Panama.

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Data Availability

Results produced during the present study will be available after the completion of the study and the publication of primary findings on reasonable request with appropriate ethical approvals and data use agreements.

Author Contributions

LS wrote the manuscript. APL and DCO conceived, managed, and coordinated the study. DCO oversaw funding acquisition. GBB carried out analyses. All authors read and wrote sections of the manuscript. All authors reviewed and approved the submitted version.

Conflicts of Interest

None declared.

Abbreviations

ADRC: Alzheimer's Disease Research Center
ADRD: Alzheimer's disease and other related dementias

ANOVA: Analysis of Variance
BNT: Boston Naming Test
CBI-USMA: Comité de Bioética en la Investigación de la Universidad Católica Santa María la Antigua
COVID-19: Coronavirus disease 2019
FLOAT: Development and Validation of TeleNeuropsychology Normative Data for Older Adults in Florida
GDS: Geriatric Depression Scale
INDICASAT: Instituto de Investigaciones Científicas y Servicios de Alta Tecnología
IOPC: Inter Organization Practice Committee
MCI: Mild cognitive impairment
MINT: Multilingual Naming Test
MoCa: Montreal Cognitive Assessment
NACC: National Alzheimer's Coordinating Center
RAVLT: Rey Verbal Learning Test
REDCap: Research Electronic Data Capture
SDMT: Symbol Digit Modality Test
SENACYT: Secretaría Nacional de Ciencia, Tecnología e Innovación
SNI: Sistema Nacional de Investigación
TeleFE: Tele Executive Function
Tele-GEMS: Tele-Global Examination of Mental State
TICS-M: Telephone Interview for Cognitive Status of Memory
TNP: Teleneuropsychology
WCST: Wisconsin Card Sorting Test
WAT: Word Accentuation Test

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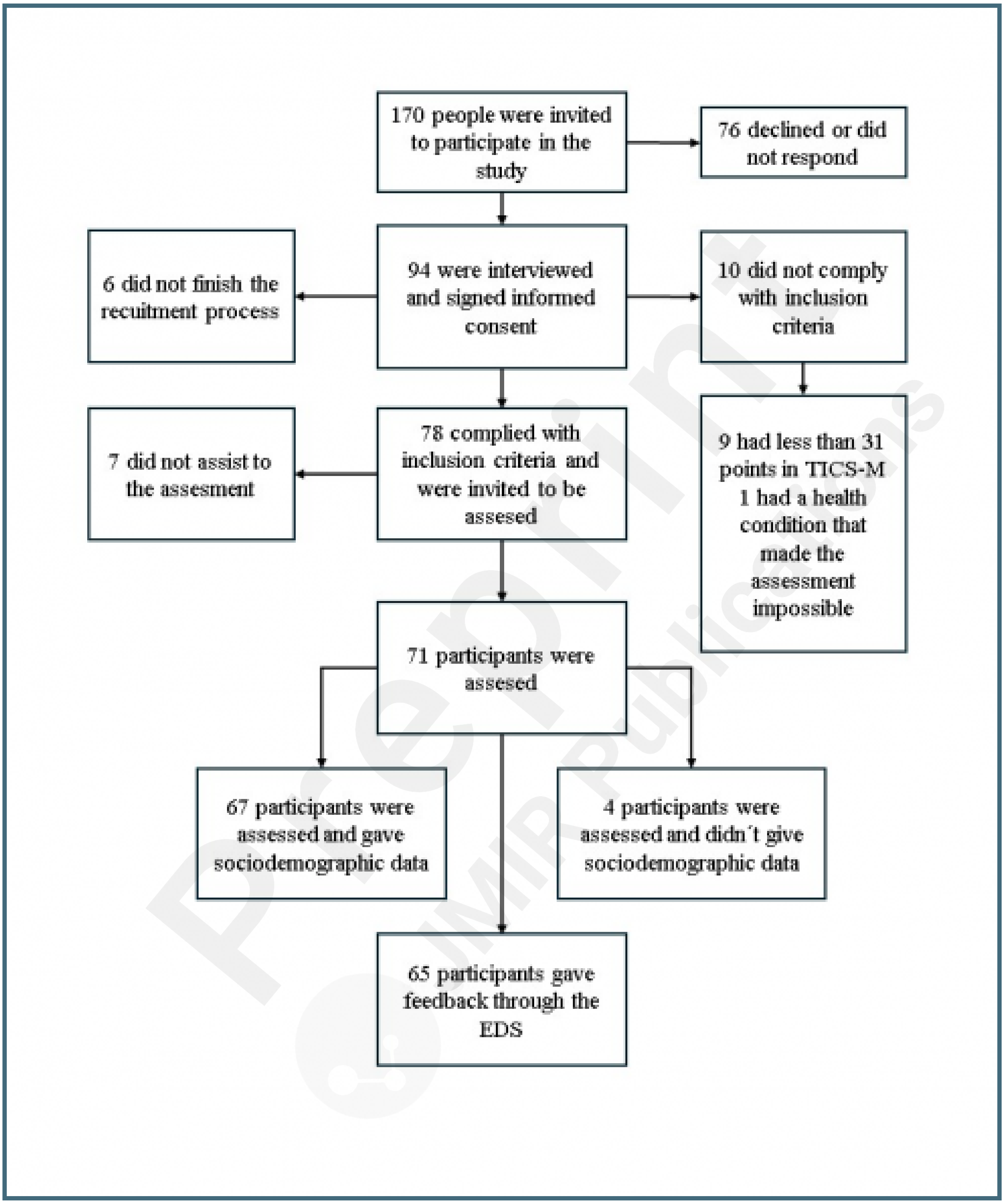
Supplementary Files

Figures

Flowchart of participants included and excluded in the study.



Flowchart of the recruitment process.