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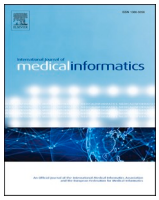

Investigating older adults' technology attitudes: Psychometric evaluation and cross-cultural adaptation of the TechPH scale

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ABSTRACT

This study aimed to examine the psychometric properties of the Turkish version of the TechPH scale (TechPH-T) among older adults. A descriptive, methodological, and cross-sectional design was employed. Data were collected between February and April 2025 using a sociodemographic information form and the TechPH-T scale. The validity of the scale was evaluated through psycholinguistic analysis, content validity, Exploratory Factor Analysis (EFA), and Confirmatory Factor Analysis (CFA). Reliability was assessed using Cronbach's alpha coefficient, item-total correlations, and test–retest reliability. The TechPH-T demonstrated excellent content validity, with a Content Validity Index (CVI) of 1.00, and showed adequate sensitivity. In the factor analyses, all factor loadings exceeded 0.30. CFA results indicated a good model fit ($\chi 2/df = 3.720$, CFI = 0.924, IFI = 0.926, GFI = 0.955, RMR < 0.01, and 90 % confidence interval of RMSEA = 0.071). The Cronbach's alpha coefficient for the overall scale was 0.702. These findings suggest that the TechPH-T is a valid and reliable instrument for assessing technology attitudes among older adults in Turkey.

1. Introduction

Technological advancements have consistently shaped human civilization by transforming societal structures and improving quality of life across diverse populations [1]. In contemporary society, these innovations hold particular promise for vulnerable groups such as older adults, offering practical solutions that support autonomy, health, and social participation [2]. As the global population ages, the integration of technology into the lives of older adults has become increasingly critical in addressing individual and societal challenges [3]. In this context, nurses have an essential role in ensuring equitable access to technology and supporting older adults through age-appropriate interventions. This study aims to evaluate the psychometric properties of the Turkish version of the TechPH (TechPH-T) scale, which measures older adults' attitudes toward technology. By doing so, it seeks to contribute to gerontechnology research and inform nursing practices that support digital inclusion in aging populations.

2. Background

Gerontechnology explores the intersection between aging and technology, with the goals of helping older people maintain independence, while improving their quality of life, and enhancing their social inclusion [4]. Regarding the last of these, integrating older adults into the modern social fabric relies on innovations such as health monitoring devices, remote care systems, digital platforms that foster social connections, and mobility and safety solutions [4,5].

In nursing practice, gerontechnology plays a fundamental role in improving older adults' health, independence, and well-being [6,7]. Technologies that reduce social isolation, provide access to care, and encourage engagement have been shown to significantly enhance the mental health and overall quality of life of older individuals [4,5], and the utilization of emerging technologies fosters their self-efficacy, empowerment and confidence in daily activities [8]. Moreover, nurses play a critical role in the effective implementation of gerontechnology by providing personalized education and training to older adults, thereby reducing technophobia and increasing acceptance and utilization of technological tools [6,7]. Nursing interventions often include facilitating the use of remote monitoring devices, assisting with digital health platforms, and integrating technology to support medication adherence and fall prevention strategies [9]. Frameworks such as the Technology Acceptance Model and the Unified Theory of Acceptance

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and Use of Technology have been adapted in nursing to better understand and promote older adults' engagement with technology [10]. These approaches not only improve care delivery but also enhance social connectedness and mental well-being, highlighting the indispensable role of nurses in bridging the digital divide among older adults.

The attitudes of older adults are critical in determining their ability to engage with and benefit from technological tools, and for nurses aiming to promote the effective adoption of technology, understanding these attitudes is essential [11]. Numerous studies have highlighted the profound impact of older adults' attitudes on their interactions with technology and their ability to leverage technological tools [12,6,11]. These attitudes are shaped by various factors, including personal experiences, health conditions, cultural and socioeconomic backgrounds, and digital literacy levels [13]. Two key constructs to be addressed to optimize the utilization of gerontechnology in nursing practice are technophilia (enthusiasm for technology) and technophobia (fear or anxiety about technology) [14].

Measuring technophilia and technophobia is essential for understanding how older adults interact with technology, ensuring that adoption aligns with their specific needs [15]. Nurses are integral in addressing these attitudes by promoting digital literacy and creating the necessary supportive environments [16]. Research underscores the importance of nurses' understanding of these attitudes to enable the development of user-friendly technologies, resources to reduce anxiety, and strategies that facilitate technology adoption [17,15,18,19], and their role in helping to cultivate a digitally inclusive society for older adults, thereby enhancing social engagement and overall well-being.

Given the unique characteristics of the older adult population, including cognitive processing abilities and familiarity with technology, it is essential that technology assessments utilize clear, concise, and culturally appropriate tools. Research has shown that struggling with complex or lengthy questions can negatively impact older adults' engagement and responses [20,21], while simplified, ccomprehensible items can enhance the reliability and validity of assessments for this group [21].

There remains a notable gap in the existing literature concerning the technological attitudes of older adults in Turkey. Specifically, there is currently no concise and psychometrically sound instrument available to assess their levels of technophilia and technophobia. The original TechPH scale, developed by [15], has been employed to measure technology related attitudes among older adults in Sweden and has subsequently been adapted for use in other cultural setting, including a recent Persian version validated by [17]. As a methodological instrument, the TechPH scale underscores the importance of conducting cross cultural validity and reliability assessments to account for potential differences in technology perceptions across cultures, rather than addressing cultural influences directly. Previous research has identified several factors that either hinder or facilitate technology adoption among older adults in diverse populations [22,23,24]. These include language proficiency, digital literacy, technophobia, and access to educational and technical support. For example, several studies have documented common challenges faced by older adults from culturally and linguistically diverse backgrounds, such as anxiety related to technology use, limited access to digital tools, and lack of motivation [22,23,24]. Moreover, research highlights that cultural values, educational background, socioeconomic status, and geographical location are critical factors that can significantly influence older adults' attitudes toward and adaptation to technology. For instance, older individuals living in rural areas or with limited financial resources may face greater challenges in accessing technological infrastructure and developing digital competencies [22]. Since these determinants are influenced by specific cultural and social contexts, it is crucial to validate measurement instruments within each unique setting to ensure accurate and meaningful interpretation. Given these considerations, culturally sensitive psychometric evaluations are essential to ensure that tools like the TechPH scale adequately capture older adults' attitudes toward technology across different sociocultural environments. Accordingly, the present study seeks to examine the psychometric properties of the Turkish version of the TechPH scale (TechPH-T). This methodological investigation aims to contribute to the expanding field of gerontechnology and to provide a reliable and valid instrument that can support nursing practice by facilitating older adults' engagement with digital technologies.

3. Methods

3.1. Design

A descriptive, methodological and cross-sectional design was used to examine the psychometric properties of the TechPH-T. This study was conducted and reported in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines, ensuring transparency and reproducibility in observational research. The cross-cultural adaptation process for the TechPH scale was followed according to the guidelines set by [25], which outline the systematic approach for adapting self-report measures to different languages and cultures.

3.2. Study setting and sampling

The study data were collected in a university hospital (in Izmir, Turkey) between February and April 2025. Those eligible were adults aged 65 years and over, literate with the ability to complete the questionnaire, who agreed to participate voluntarily and had no cognitive impairment at the time of the study (as assessed through review of hospital epicrises for any documented cognitive or neurological diagnoses). Since this study aims to assess the psychometric properties of the TechPH within the Turkish cultural context, participants needed to have at least some, even if very limited, experience of technology use. This is necessary because the scale items assess experiences and perceptions related to technology usage, and those with no prior exposure would be unable to provide meaningful responses. Therefore, those who had never or only rarely used technology were excluded to ensure the validity and reliability of the responses. Non-random sampling (convenience sampling) was used in the study.

In scale development, and validity and reliability studies, it is reported that a sample size of $\leq$ 100 people is insufficient, between 101–200 is moderate, between 201–300 is good, between 301–500 is very good, and more than 501 people is excellent [26,27]. In addition, the literature also recommends that the sample size in scale adaptation studies should be 5 to 10 times the number of items in the scale [28]. In validity and reliability studies, it has been documented in the literature that beyond a certain point, increased sample size fails to improve the scale's outcomes. Moreover, excessively large samples may lead to overpowered statistical tests, making even minor and practically insignificant differences appear statistically significant [28]. Considering the literature recommendations, for six item scale, the sample of the study consisted of 217 older adults.

3.3. Instruments

3.3.1. Demographic and characteristic form

The researchers developed the form specifically to collect data on the sociodemographic characteristics of older adults. It consisted of questions focused on characteristics such as age, gender, income level. Further questions focused on how older adults feel when using technological devices, their difficulty in using technological tools, and their enthusiasm for following technology (Table 1).

3.3.2. TechPH scale

Anderberg et al. [15] developed and validated the TechPH scale to evaluate older adults' attitudes toward technology in Sweden. This instrument consists of six items, and an exploratory factor analysis

Table 1
Descriptive characteristics of the older adults (n: 217).

Variables	n	(%)
Sex		
Female	113	52.10
Male	104	47.90
Marital Status		
Married	163	75.10
Single	54	24.90
Education Status		
Primary Education	139	64.10
High School	63	29.00
University	15	6.90
Financial status		
Low income	40	18.40
Moderate income	121	55.80
High income	56	25.80
How often do you use technological devices?		
Always	43	19.80
Most of the time	108	49.80
Rarely	66	30.40
How do you feel when using technological devices?		
Stressful	94	43.30
Neither stressful nor comfortable	50	23.30
Comfortable	73	33.60
Do you have difficulty learning technological tools?		
Yes	161	74.20
No	56	25.80
Do you feel lonely because of technological tools?		
Yes	84	38.70
No	133	61.30
What do you think about following and learning about technological innovations?		
I am interested	52	24.00
I am not interested	92	42.40
I find it difficult	57	26.30
I am afraid	16	7.40
Does it excite you to follow technological innovations?		
Yes	58	26.70
No	153	73.30
Do you see technology as a tool to make your life easier?		
Yes	168	77.40
No	49	22.60

identified two distinct factors: tech enthusiasm (items 1,2,3) and tech anxiety (items 4,5,6). The scale demonstrated satisfactory internal consistency, with Cronbach's alpha values of 0.72 and 0.68 for the respective factors. Each item is assessed on a 5-point Likert scale, where 1 represents strong disagreement and 5 represents strong agreement, with items pertaining to technophobia being reverse-scored. The total score ranges from 1 to 5, with higher scores indicating a greater affinity for technology [15]. Authorization to use the TechPH scale was obtained from Professor Dr. Peter Anderberg, the principal author of the original study. Subsequently, the tool underwent a translation process and psychometric evaluation. The scale was originally developed in English, and the validated Turkish version of the scale is presented in **appendix (A.1)**.

3.4. Data analysis

Statistical evaluation of the data was conducted using the Statistical Package for the Social Sciences version 23.0 (SPSS Inc, Chicago, IL, USA) and Analysis of Moment Structures (AMOS) version 26.0. Number and percentage distributions of the descriptive data were used. Reliability was determined using Cronbach's alpha, item-total correlations, test–retest, ceiling and floor effects and Hotelling's T-squared test for response bias [29]. Validity analysis was conducted via language and concept validity, content and construct validity, and known group comparison. The hypothesis of the study was as follow: The TechPH-T was a valid and reliable measurement tool for older Turkish people.

Validity covered language and concept validity, content validity and construct validity. For psycholinguistic validity, the investigators of this study first independently translated the scal from English to Turkish and then collaborated on determining the most appropriate translation for each item in the Turkish version. The back translation of the scale from Turkish to English was done by a language expert who had not previously seen the English version and who had a good understanding of both languages and cultures. The entire study team held three meetings about scale translations. In one meeting, the researchers compared the translated English form with the original form. For content validity, the language adaptation of the scale was carried out by experts who evaluated the suitability of the items for Turkish culture. The process of ensuring language validity in this study was designed in accordance with the framework proposed by [30], which emphasizes following the principles of good practice for translation and cultural adaptation.

Content validity was confirmed by a panel of eleven experts who evaluated the scale in terms of language and content. The panel consisted of eight nursing academics, one physiotherapist and two clinician nurses working in the field of geriatrics or with published scale validity and reliability studies. Expert evaluations were obtained using the Davis Technique Content Validity Index (CVI). The ratings were analyzed using the Davis Technique, which involved calculating the proportion of experts relative to the total number who rated an item as either suitable or slightly suitable. A CVI of ≥ 0.80 is deemed adequate to establish the content validity of the items [31].

To test the clarity and intelligibility of the items, the scale was given to a small representative group of the sample. There are different methods of calculating the sample for the pilot study. In the literature, it was recommended that the scale should be assessed in a small pilot study consisting of 20–30 persons not included in the sample [28]. In this study, the background literature indicated that a pre-application could be made with a group of 30. Each of the items in the pilot study was found to be comprehensible. The researchers administered the scale face-to-face to the older adults, and it took approximately 5–10 min to complete. Pre-application data were excluded from the scope of this study. In the pilot study, after completing the scale items, the older adults were asked the following: What are your general impressions of the instrument? What are your thoughts on each individual item? Is the number of questions deemed acceptable? Does the sequence of the questions appear logical to you? Did you encounter any difficulties in answering or comprehending any of the items? Overall, how clear and user-friendly is the instrument? Are there any issues with the rating scale, and do you have any suggestions for improvement? Are there any other recommendations that you have for enhancing the instrument? The qualitative feedback indicated that the scale was generally perceived as clear, relevant, and appropriately structured. The results of the pilot study confirmed that the instrument was largely comprehensible and suitable for administration to the target population of older adults in Turkey. No revisions were made to the scale items following the pilot phase, as the content was deemed acceptable in its current form.

Cultural differences have been shown to exert a significant influence on factor structures, and these differences can impact the allocation of items to specific factors [32]. In this context, literature increasingly supports the necessity of conducting Exploratory Factor Analysis (EFA) in cultural adaptation studies, even when no new scale is developed. Specifically, EFA plays a critical role in understanding how cross-cultural similarities and differences can affect the factor structures of measurement instruments [32]. Prior to conducting the EFA, several tests were performed to assess the suitability of the data for factor analysis. Data were examined to determine whether they were normally distributed. The Kaiser-Meyer-Olkin (KMO) test was used to assess sampling adequacy, and Bartlett's test of sphericity was conducted to evaluate whether the measurement tool could be divided into distinct factor structures. In the factor analysis, principal components analysis (PCA) was employed, followed by direct oblimin method to enhance interpretability [32]. For the CFA, model fit was evaluated using various goodness-of-fit indices (GFIs), including Pearson's $\chi 2$, degrees of

freedom, root mean square error of approximation (RMSEA), goodness-of-fit index (GFI), comparative fit index (CFI), and normed fit index (NFI) [32].

The test–retest method was employed to assess the reliability of the scale in terms of stability [28]. For test–retest analysis, it is advised that the test–retest sample should represent 10–20 % of the total sample [28]. In this study, the total sample consisted of 217 participants, and the test–retest application was administered to 32 older adults, which corresponds to approximately 14.7 % of the total sample, with a three-week interval. This interval was chosen to ensure that the time between tests was sufficiently long to prevent participants from recalling their previous responses; a two-to-three-week gap is recommended for such assessments. EÖ, NHD, GNÇ were responsible for conducting and evaluating the test–retest application.

3.5. Ethical considerations

Permission was obtained from the author (Professor Dr. Peter Anderberg) by e-mail to translate TechPH into Turkish and evaluate psychometric properties. The ethical review committee of the foundation university approved the study (approval date: 20 January 2025). Participants were informed about the aim and design of the study after providing oral and written informed consent, which was required before filling the survey.

4. Results

4.1. Characteristic of the sample

The sample of the study (n = 217) consisted of 113 women (52.1 %) and 104 men (47.9 %). Their ages ranged from 65 to 93 (72.21 ± 6.23). The majority were married (75.1 %), with 64.1 % having completed education to elementary level. Furthermore, 85.7 % of the participants were not in employment, and 55.82 % reported that their income was sufficient to cover their expenses. In addition to demographic data, the form also included questions aimed at eliciting participants' adaptation to technology. In response to these questions, 49.8 % of the older adults reported using technology frequently, while 43.3 % reported experiencing stress when using technological devices. Furthermore, 74.2 % of the participants indicated that they have difficulty learning how to use technology, 42.4 % expressed no interest in technological innovations, and 77.4 % believed that technology makes life easier (Table 1).

4.2. Validity

4.2.1. Face and content validity

Four areas of validity were considered: language and concept validity, content validity and construct validity. Expert evaluations were obtained using the Davis Technique CVI. A CVI of $\geq$ 0.80 is deemed adequate to establish the content validity of the items [31]. In this study, the CVI score was 1.00, showing a perfect fit.

4.2.2. Exploratory Factor Analysis (EFA)

In order to determine the factor structure of the scale, EFA was performed with the entire sample of 217. The data were found to show a normal distribution. Since the Kolmogrov-Smirnov test value was $p > 0.05$, it was accepted that the scores obtained from the scale exhibited a normal distribution. KMO value = 0.709 was found to be good [29]. Barlett Sphericity test x^2 value = 134.316 ($p < 0.001$). As a result of EFA, two factors with eigenvalues greater than 1 were determined in Turkish society. These two factors explain 62.291 % of the total variance. As a result of EFA, the scree plot revealed that a total of two factors contributed to the explained variance up to the point where the graph flattened (Fig. 1). Of the total variance of 62.291 %, 39.584 % was explained by the first factor, and 22.707 % by the second. The distribution of the items to the factors was examined with direct oblimin method.

The factor loadings in the tech enthusiasm subscale ranged from 0.72 to 0.82 (item 1,2,3), and in the tech anxiety subscale from 0.13 to 0.80 (item 4,5,6). The factor loadings for the items in both the tech enthusiasm and tech anxiety subscales demonstrate excellent correlations for items 1–5, reinforcing the scale's robustness and validity in measuring

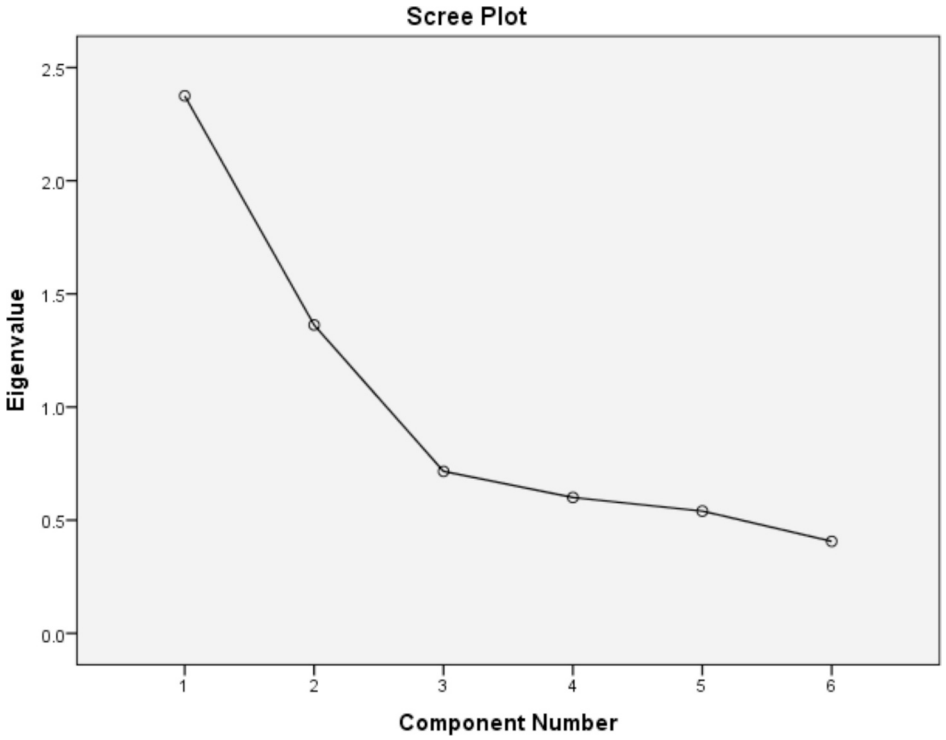

Fig. 1. Scree plot of exploratory factor analysis for the Turkish version of the TechPH scale.

these constructs. However, item 6 ("I would have dared to try new technical gadgets to a greater extent if I had had more support and help than I have today") exhibited a factor loading of 0.13 on the tech anxiety subscale and a high correlation of 0.72 with the tech enthusiasm subscale when corrected for reverse coding. The low factor loading of 0.13 on the tech anxiety subscale suggests that the item does not adequately capture participants' anxiety towards technology. Moreover, the significant correlation of 0.72 with tech enthusiasm indicates that this item in fact reflects enthusiasm, rather than directly measuring anxiety, in the Turkish context.

4.2.3. Confirmatory Factor Analysis (CFA)

CFA was conducted to make a more informed decision regarding the classification of Item 6, which exhibited a low factor loading (0.13) on the tech anxiety subscale and a significantly high factor loading (0.72) on the tech enthusiasm subscale. While the EFA results provided valuable insights into the initial factor structure, CFA was crucial to further validate the proposed factor structure and ensure the scale's reliability and robustnessin the Turkish cultural context. Previous research indicates that cultural differences can significantly affect factor structures, and this was reflected in the poor model fit indices observed in the CFA of the original scale for the Turkish sample. Specifically, the model fit indicators in the initial CFA were as follows: CFI = 0.829, incremental fit index (IFI) = 0.835, GFI = 0.898, root mean square residual (RMR) < 0.01, chi-square/degree of freedom (x^2/df) = 4.687 ($p < 0.001$), and 90 % confidence interval of RMSEA = 0.193. Based on these findings, it was decided to transfer Item 6 to the tech enthusiasm subscale with the permission of Professor Dr. Peter Anderberg.

After making adjustments to the item, CFA was rerun with the same sample. The updated model fit indicators are as follows: CFI = 0.924, IFI = 0.926, GFI = 0.955, RMR < 0.01, x2/df = 3.720 ($p < 0.001$), and the 90 % confidence interval of RMSEA = 0.071. This change significantly improved the model fit, and also positively impacted internal consistency, as evidenced by an increased Cronbach's Alpha, detailed in the reliability analysis section (Fig. 2).

Following the transfer of the 6th item, the KMO value was found to be good (0.684) [29], and the Bartlett's Sphericity test yielded a chi-square value of 297.113 ($p < 0.001$). Additionally, there was an improvement in the variance explained by the factors. Two factors together explained 63.226 % of the total variance, with the first factor accounting for 41.819 % and the second factor explaining 21.407 %.

In this study, a comparison test was conducted to assess the technology adaptation of older adults based on known groups. It is accepted that individuals who experience difficulties in learning technology may have lower levels of adaptation [33], therefore, our study involved a known group comparison based on older adults' responses to the question *"Do you have difficulty learning technological tools?"*in the demographic data form. The results showed that the average TechPH-T scale score of those who reported difficulty learning technology (3.25 ± 0.60) was lower than that of those who did not (3.46 ± 0.52). A statistically significant difference was found between the two groups ($p = 0.015$).

4.3. Reliability

The Cronbach's α value calculated for for TechPH-T was 0.702 tech enthusiasm subscale (item 1,2,3,6) was 0.764, and 0.600 for tech anxiety subscale (item 4,5). To determine whether or not the items were distinctive, we performed item-total score and item-subdimension total score analysis, given in Table 2 shows that the item-total score correlation coefficients of the scale vary between 0. 231 and 0.634, and item-subdimension total score correlations were determined as follows: 0.505–0.668 for tech enthusiasm, 0.231–0.415 for tech anxiety. All correlation values were found to be significant at the < 0.001 level.

The test–retest application was given to 32 older adults three weeks apart, and for both the scales' sub-dimensions, a statistically significant positive relationship was observed between the test–retest scores. The first sub-dimension had an $r = 0.91$ and $p < 0.001$, the second had an $r = 0.96$ and $p < 0.001$, and the total score had an $r = 0.95$ and $p < 0.001$. No significant difference was observed at the 0.05 level as a result of the t test between the factors and the total score in the dependent groups.

The assessment of scale homogeneity was evaluated with floor and ceiling effect analysis [34]. The evaluation of the data showed that the scale's floor and ceiling effect analysis was below 15 %. Response bias was evaluated to test whether the answers were in line with participants' own opinions or with the community's or researcher's expectations. As a result of this test, Hotelling's T-squared = 514.839 of the scale was considered to be significant ($p < 0.001$).

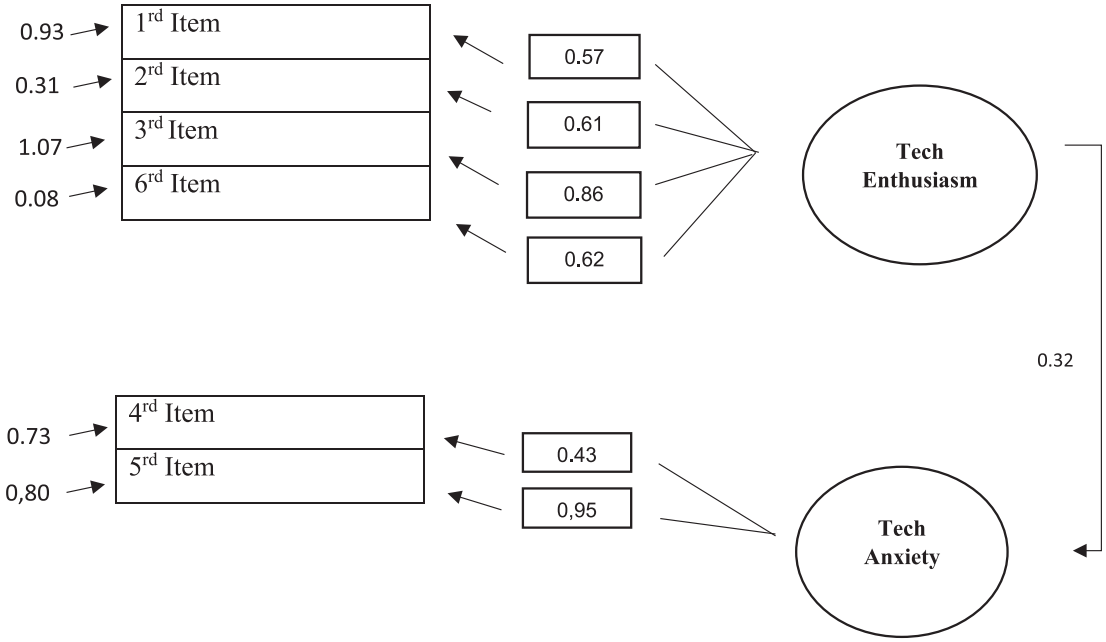

Fig. 2. The results of confirmatory factor analysis of Turkish version of TechPH scale.

Table 2
Item–total score and item–subdimension total score correlations of Turkish version of TechPH Scale (n = 217).

		Item–Total Score Correlations	Item– Subdimension Total Score Correlations
Items**		**r***	**r***
1	I think it's fun with new technological gadgets.	0.459	0.517
2	Using technology makes life easier for me.	0.231	0.414
3	I like to acquire the latest models or updates.	0.543	0.563
4	I am sometimes afraid of not being able to use the new technical things.	0.340	0.414
5	Today, the technological progress is so fast that it's hard to keep up.	0.634	0.668
6	I would have dared to try new technical gadgets to a greater extent if I had.	0.415	0.505

* $p < 0.001$ **Turkish version was administered to the participants.

5. Discussion

In light of the global push towards digital inclusion and the principles outlined in the United Nations Sustainable Development Goals, it has become increasingly criticial to understanding older adults' attitudes toward technology [35,36]. This particularly related to Goal 3 (Good Health and Well-being), Goal 9 (Industry, Innovation and Infrastructure), and Goal 10 (Reduced Inequalities). As societies age, technological integration becomes increasingly crucial to health, communication, and social engagement. Thus, it becomes even more important to assess and adapt measurement tools such as the TechPH scale to promote equitable and sustainable development [35,36]. This study aims to contribute to the literature by providing a culturally adapted and psychometrically validated tool for evaluating technology related attitudes among older adults in Turkey, a population often underrepresented in digital innovation discourse.

Although previous studies employed larger sample sizes (e.g., Anderberg et al., n = 374; Abdipour et al., n = 420), the psychometric findings obtained in our study were similarly robust [15,17]. According to the literature, once an adequate sample size is reached, further increases tend to yield diminishing returns in terms of psychometric improvement. Furthermore, overly large samples may lead to statistically significant results that lack practical relevance [28]. In this regard, the sample of 217 older adults included in our study is deemed sufficient and methodologically appropriate for conducting validity and reliability analyses of the scale. Additionally, the sociodemographic characteristics of participants in our study are similar to those reported in the original scale development and adaptation studies.

The translation-back translation method was used to evaluate the language validity of the scale. In this study, the CVI score was 1.00, indicating a perfect fit, and a good level of agreement among experts that the TechPH-T accurately measures the intended construct. The original version of the scale was developed in 2019 by Anderberg et al., with a sample of Swedish older adults [15]. Later, Abdipour et al. [17] examined the psychometric properties of the Persian version of the scale [17]. However, apart from these two, we know of no other studies investigating the psychometric properties of the TechPH scale in different cultural contexts. In the original scale development study, no CVI score was reported, but in the study by Abdipour et al., a score of 0.95 was found, and was interpreted as indicating a perfect fit, which is consistent with the findings of the present study [17].

Although this study is an adaptation rather than a scale development, EFA was conducted to examine whether the scale preserved original version's factor and item structure in the Turkish cultural context [32]. The findings supported the use of EFA in this context: while the scale showed a similar two-factor structure to the original, there were differences in item distributions across factors. The EFA revealed a 2-factor, 6-item structure consistent with the studies of Anderberg et al. and Abdipour et al. [15,17]. Factor loading values were interpreted based on established criteria: 0.32–0.50 as low, 0.50–0.60 as moderate, 0.60–0.70 as high, and above 0.70 as excellent [37]. In Anderberg et al.'s study, factor loadings ranged from 0.60 to 0.86 for the tech enthusiasm subscale and from 0.53 to 0.75 for the tech anxiety subscale [15]. Similarly, Abdipour et al. reported loadings between 0.64 and 0.75 for the tech enthusiasm subscale and 0.51–0.90 for the tech anxiety subscale [17]. In the current study, the tech enthusiasm subscale (items 1, 2,3) had high factor loadings ranging from 0.72 to 0.82, in line with the literature. However, a notable finding emerged regarding item 6 ("I would have dared to try new technical gadgets to a greater extent if I had had more support and help than I have today") its factor loading on the tech anxiety subscale was low (0.13), but after reverse coding, it showed a high correlation (0.72) with the tech enthusiasm subscale. This suggests that item 6 may not effectively reflect technology-related anxiety, as originally intended. In this context, although the EFA suggested that item 6 should be included in the tech enthusiasm subscale, CFA was conducted to confirm this revised structure by evaluating model fit indices [32]. In the initial model (before moving item 6), the fit indices were as follows: CFI = 0.829, IFI = 0.835, GFI = 0.898, RMR < 0.01, χ^2/df = 4.687 ($p < 0.001$), and RMSEA = 0.193 (90 % CI). After consultation with the developers of the original scale, Peter Anderberg it was decided to reassign Item 6 to the "technology enthusiasm" sub-dimension. This change was made in order to reflect the particular cultural characteristics of the Turkish context. Subsequently, the updated model fit indices are as follows: CFI = 0.924, IFI = 0.926, GFI = 0.955, RMR < 0.01, $\chi^2/df = 3.720$ ($p < 0.001$), and RMSEA = 0.071 (90 % CI). This revision significantly improved the model fit and confirmed that item 6 aligns better with the tech enthusiasm subscale. Anderberg et al. reported excellent model fit (CFI = 0.97, AGFI = 0.95, RMSEA = 0.067, SRMR = 0.036) [15]. Similarly, in the Persian adaptation study where item 6 remained in the tech anxiety subscale, Abdipour et al. found a good fit (CFI = 0.978, RMSEA = 0.061, CMIN/DF = 1.769) [17]. Notably, after relocating Item 6 to the technology enthusiasm subdimension, the revised Turkish model demonstrated a significantly improved model fit. These findings suggest that Turkish participants may interpret this item differently than participants from other cultural contexts. The original *item "I would have dared to try new technical gadgets to a greater extent if I had had more support and help than I have today"* was intended to measure technological hesitancy and anxiety. However, the Turkish translation may convey a distinctly different connotation. In English, the phrase *"I would have dared to"* typically implies internal inhibition, self-doubt, or fear of failure. In contrast, the Turkish equivalent *"Bu teknolojiyi denemeye cesaret ederdim"* is often interpreted not as an expression of hesitation, but rather as a latent eagerness or a readiness to engage when adequate social or emotional support is available. This distinction can be better understood within the broader framework of Turkish cultural attitudes toward social support and learning processes. In Turkish society, seeking help is not generally perceived as a sign of weakness or technological incompetence, but rather as a socially endorsed and collaborative pathway to growth. Especially among older adults or individuals with limited technological experience, being introduced to new technologies with the assistance of others often generates curiosity and a sense of empowerment. Rather than stemming from anxiety, the act of receiving support is commonly internalized as a motivating factor for exploration and engagement. This culturally embedded interpretation may explain why item 6 aligns more closely with technology enthusiasm than with anxiety in the Turkish version of the scale. It underscores the importance of considering not only linguistic equivalence, but also conceptual and contextual equivalence during adaptation processes. As Faniran et al. [38] emphasize,

constructs such as technology-related enthusiasm or anxiety are deeply shaped by cultural norms and values, necessitating culturally sensitive approaches to measurement [38].

To assess the discriminative ability of the factors, a comparison test was conducted on two known groups, identified based on their responses to the question, "Do you have difficulty learning technological tools?". The TechPH-T score was found to be statistically significantly lower for individuals who reported difficulty in learning technology, compared to those who did not. Similarly, Anderberg et al. [15] and Abdipour et al. [17] also compared the TechPH scale mean scores based on sociodemographic characteristics and found statistically significant differences in the scale mean scores ($p < 0.05$) [15,17]. These results suggest that the scale demonstrates discriminative validity, as it effectively differentiates individuals based on the characteristics it is intended to measure.

Following the validity analyses, reliability analyses were conducted. In the internal consistency coefficient used to assess the scale's reliability, the Cronbach's α coefficient for the total scale was 0.702, with sub-dimensions ranging from 0.600 to 0.764. In the literature, a Cronbach's alpha coefficient of 0.600 is generally considered the minimum acceptable threshold for internal consistency reliability [37]. The lower Cronbach's alpha observed for the tech anxiety subscale is attributed to the limited number of items within this factor [37]. Furthermore, it has been reported that this subscale in the original scale demonstrates a lower Cronbach's alpha compared to the overall scale and the techno enthusiasm subscale [15]. In the original TechPH scale sub-dimensions, which ranged from 0.68 to 0.72 [15]. In the study by Abdipour et al., Cronbach's α coefficients were reported total scale was 0.77, with sub-dimensions ranging from 0.70 to 0.71 [17]. Scores from 0.60 to 0.80 indicate that the tool is reliable [37]. Based on these results, the reliability of the total scale and its sub-dimensions is considered to be highly satisfactory.

The item-total score correlation coefficients were calculated to determine whether or not the items were related to the feature to be measured, and to determine the relationship between the whole and the part [28]. Correlation coefficients should not be less than 0.20 [28]. Item-total correlation coefficients should be positive and above 0.20. In this context, it may be remarked that each item is important for the overall scale. These data were not included in the original and adapted versions of the scale, and therefore, comparisons were not feasible.

The test–retest method was used to determine the reliability of the scale in terms of stability [28]. The scale scores in the test–retest were also compared with the *t*-test (dependent groups *t*-test). The mean scores of the scales administered to the same group with an interval of 3 weeks were compared, and it was determined that there was no statistically significant difference between the two measurements ($p > 0.05$). Anderberg et al. and Abdipour et al. assessed reliability using the Intraclass Correlation Coefficient (ICC), which measures the test's consistency and the degree of agreement between measurements [15,17]. While the *t*-test evaluates the significance of differences between two measurements, ICC focuses on the overall reliability of the scale [39]. In both Anderberg et al. and the Abdipour et al.'s studies, the ICC was found to be 0.85, indicating a high level of reliability and significant agreement between the first and second test scores ($p < 0.001$) [15,17]. These findings confirm the scale's strong reliability and consistency.

To assess the potential response bias, which can influence the scale's reliability, we examined whether participants' answers were influenced either by societal factors or the presence of the researcher. The Hotelling T-square test was utilized to assess response bias and determine if the sample's mean was normally distributed. The statistically significant result indicated the absence of response bias, suggesting that participants answered based on their own perspectives, and their responses varied accordingly [34]. Hotelling's T-squared test indicated no response bias in the data. However, potential social desirability bias, which is common in self-reported attitude scales, was not controlled in this study, this is added as a limitation section. As these data were not part of the original or adapted scale versions, no direct comparisons could be made. The assessment of scale homogeneity was evaluated with floor and ceiling effect analysis; an effect below 15 % shows that the scale is reliable [34]. Based on the floor and ceiling effect, the scale was found to produce reliable results.

5.1. Strength and Limitations of the work

A key limitation of this study is the use of convenience sampling, which may reduce the generalizability of findings. This study involved a non-probabilistic sample, which may limit the generalization of the results. The lack of representation from subgroups such as rural or low-income older adults may limit the diversity of perspectives. Therefore, future studies should consider stratified sampling to improve representativeness.

In addition, the data were collected through self-report measures, and responses may have been influenced by social desirability or subjective interpretation, which could affect the accuracy of the results. A limitation of this study is the lack of control for potential social desirability bias, which may have influenced participants' self-reported responses. Finally, one of the items in the scale was moved from its original factor to a different factor based on EFA and CFA. While this adaptation was statistically supported, it may affect the comparability of the TechPH-T with the original version and could potentially influence the construct validity.

5.2. Implications for policy and practice

The validated Turkish version of the TechPH scale offers a reliable tool for assessing older adults' attitudes toward technology. This provides healthcare professionals and policymakers with the opportunity to develop more targeted and inclusive digital health strategies. By identifying variations in individuals' levels of enthusiasm for and anxiety about technology, the scale can help detect older adults at risk of digital exclusion. Integrating the TechPH scale into routine geriatric assessments may guide the development of personalized interventions, digital literacy training, and support mechanisms tailored to the specific needs and capacities of older individuals. Such person-centered approaches are essential for enhancing digital engagement and promoting interaction with health technologies among the aging population. Furthermore, the findings emphasize the importance of ensuring that digital health assessments, such as the TechPH Scale, are culturally relevant and valid for diverse populations. The validated Turkish version can serve as a reliable tool for use in healthcare professionals' assessment of older adults' attitudes toward technology, guiding the development of more tailored digital health strategies in Turkey.

6. Conclusion

The results obtained from this study showed that the TechPH-T is a valid and reliable measurement instrument for determining older adults' technology attitudes in Turkey. This scale will also be beneficial for professional groups carrying out studies in the health field to serve the aging population. By identifying older adults' technology attitudes, these professionals will be able to design projects that promote digital inclusion, support the development of age-friendly technologies, and enhance the design of tailored interventions to improve their quality of life. In particular, the use of this scale can guide nursing practices through promoting the assessment and understanding of older individuals' attitudes toward technology, thereby enabling the planning and implementation of personalized care strategies that integrate technological solutions to support health monitoring, self-care, and overall well-being.

Data sharing and data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

CRediT authorship contribution statement

Ecem Özgül: Writing – original draft, Visualization, Methodology, Formal analysis, Conceptualization. **Nedime Hazal Döner:** Writing – original draft, Methodology, Conceptualization. **Gülsüm Nihal Çürük:** Writing – original draft, Visualization, Methodology, Conceptualization.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijmedinf.2025.106001.

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