Development and Validation of the Korean Digital Health Literacy Scale for Elderly: A Comprehensive Tool for Assessing Digital Health Literacy

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Abstract

Background: New healthcare services such as smart healthcare and digital therapeutics have greatly expanded. To effectively utilize these services, digital health literacy skills, involving the use of digital devices to explore and understand health information, are important. Older adults requiring consistent health management highlight the need for enhanced digital health literacy skills. To address this issue, it is imperative to develop methods to assess older adults' digital health literacy levels.

Objective: This study aimed to develop a tool to measure digital health literacy. To this end, it reviewed existing literature to identify the components of digital health literacy, drafted preliminary items, and developed a scale using a representative sample.

Methods: We conducted a primary survey targeting 600 adults aged 55–75 years and performed an exploratory factor analysis on 74 preliminary items. Items with low factor loadings were removed, and their contents were modified to enhance their validity. Then, we conducted a secondary survey with 400 participants to perform exploratory and confirmatory factor analyses.

Results: A digital health literacy scale consisting of 25 items was developed. This scale comprises four sub-factors: utilization of digital devices, understanding health information, utilization and decision regarding health information, and use intention. The validity and reliability test results indicated that this scale is highly reliable and has good structural validity.

Conclusions: This study is a significant first step toward enhancing digital health literacy among older adults by developing an appropriate tool for measuring digital health literacy. We expect this study to contribute to the future provision of tailored education and treatment based on individual literacy levels.

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Abstract

Background: New healthcare services such as smart healthcare and digital therapeutics have greatly expanded. To effectively utilize these services, digital health literacy skills, involving the use of digital devices to explore and understand health information, are important. Older adults, requiring consistent health management highlight the need for enhanced digital health literacy skills. To address this issue, it is imperative to develop methods to assess older adults' digital health literacy levels.

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Keywords: digital healthcare, older adults, digital health literacy, exploratory factor analysis, confirmatory factor analysis

Introduction

Background

The proliferation of digital technology and widespread use of smart devices have facilitated convenient and ubiquitous access to current information and services. The worldwide adoption rate of smartphones is approximately 76%, with South Korea having the highest rate at 95% [1]. The diverse services in the digital realm can immensely benefit individuals utilizing them [2]. Cutting-edge medical services, such as digital therapeutic gadgets, intelligent monitoring, and telemedicine are intricately connected to the digital revolution in healthcare [3]. The medical device sector, in an attempt to actively identify and meet patient needs, develops digital healthcare services at medical treatment sites. These digital healthcare services improve the accessibility of medical care and individualized therapy [4]. For instance, the utilization of smartphone applications for medication reminders and the implementation of disease monitoring systems that rely on patient-generated health data (PGHD) prove highly beneficial for patients with chronic illnesses [5]. To effectively utilize digital healthcare services, patients and those without underlying medical conditions must possess the necessary skills to retrieve and utilize the desired health information in the digital domain [6,7].

Digital health literacy is a newly developed term that combines two distinct concepts: health and digital literacy [8]. Beyond comprehending health information, it includes the ability to efficiently use digital tools and resources for healthcare. However, the adoption of new technologies varies with the social environment and individual abilities. These disparities contribute to a digital divide and information gap. In South Korea, digitally marginalized groups, including older adults, rural areas residents, individuals with disabilities, and low-income individuals, are unable to keep up with advancements in digital technology [9], with studies recognizing the digital divide as a noteworthy societal problem among these populations [10-12]. The most vulnerable group is the older adult population, who have limited exposure to smart devices and limited opportunities for education in information and communication technology [13]. The COVID-19 pandemic has exacerbated this phenomenon [14].

By 2025, South Korea's population aged 65 years and older is projected to surpass 20% of the total population [15]. Over the next decade, population aging is expected to worsen, with the proportion of older adults steadily increasing [16]. Consequently, South Korea and other countries with aging populations have

recognized digital exclusion among older adults as a new social issue. Older adults experience difficulties utilizing everyday technologies such as kiosks and self-checkout counters and medical services such as digital therapeutic devices and telemedicine [17]. Although social support can motivate older adults to utilize digital technologies [18], those living alone may have limited access to digital healthcare services owing to a lack of assistance from family members. Therefore, it is crucial to develop a strategy that enhances the digital health literacy level among those lacking access to digital services.

Enhancing digital health literacy can offer significant health benefits for individuals [19]. Individuals utilizing digital health services understand which information is most appropriate for their needs, while service providers can deliver optimum services to them [20]. For instance, wearable devices such as smartwatches can transmit real-time vital health signs data including temperature, heart rate, blood pressure, and stress levels, to healthcare providers, thereby enabling continuous monitoring of patients' conditions [21]. To improve digital health literacy, it is essential to assess the current level of digital health literacy among users. Nevertheless, comprehensive research specifically examining and quantifying the different aspects of digital health literacy is lacking [22].

According to Norman and Skinner [23], digital health literacy refers to the capacity to locate, comprehend, assess, and utilize electronic health information to address health concerns. They developed a measurement tool comprising eight items; however, this assessment was insufficient in evaluating digital health literacy comprehensively [24]. Van Der Vaart and Drossaert [25] developed the Digital Health Literacy Instrument (DHLI) to measure various competencies, emphasizing the ability to use internet information. However, their study's reliance on a highly educated sample might have overestimated digital skills, and the limited platforms used could affect generalizability. Karnoe et al. [26] categorized digital health literacy into seven components—four related to health literacy and three to digital literacy—and developed a corresponding measurement scale. However, this scale only evaluates the comprehension of health information and the utilization of digital technologies without considering social literacy elements such as information sharing. Although studies have attempted to evaluate digital health literacy, survey items that can comprehensively investigate all aspects of digital health literacy are limited. Furthermore, these studies do not adequately represent certain populations such as older adults or low-income individuals.

Objective

This study aimed to identify the fundamental components of digital health literacy among older adults and develop a systematic self-report scale that can be used to effectively assess their level of digital health literacy.

Material and Methods

Overview

This study investigated the subjective experiences of digital health literacy among older adults, focusing on their ability to utilize digital technologies and skills in searching for, understanding, and utilizing health information. We used two approaches to create an item pool: a literature review to identify digital health literacy components and focus interviews with healthcare experts to validate these items. Subsequently, we employed a two-step survey and analysis using exploratory and confirmatory factor analyses.

This study was reviewed and approved by the Institutional Review Board of the Catholic University of Korea, Songeui Campus (MIRB 20230825-007).

Development of the Digital Health Literacy Scale

We reviewed existing scientific literature to identify relevant theories describing motivations, functionality, and experiences with technology use. Healthcare and mental health experts searched the National Library of Medicine PubMed database, Web of Science, Scopus, and Science Direct using keywords such as "Digital Health Literacy scale," "Mobile health device," "e-Health," and "Health Literacy," focusing on older adults and healthcare technology. The existing scales were then reviewed, and relevant survey items were added to the item pool. We examined several key instruments: the Mobile Device Proficiency Questionnaire (covering basics, communication, data storage, and Internet use), European Health Literacy Survey Questionnaire (assessing the ability to understand and process health information), Unified Theory of Acceptance and Use of Technology (evaluating perceived usefulness, ease of use, and attitudes), DHLI (focusing on the reliability of healthcare information), and Transactional eHealth Literacy Instrument (related

to health information communication) [26-30].

Our second approach involved a focus group interview with 10 experts from nursing, social work, public health, education, and medicine. The experts provided feedback on the proposed items related to older adults' digital technology use and needs in the medical environment and suggested new items. The initial item pool included 74 items: 59 from the literature review and 15 from focus group interviews (SI).

Participants and Data Collection

The target population comprised Korean adults aged 55–75 years. We recruited 1,000 participants through emails, text messages, and website visits. Ability to communicate orally and in writing and smart-device experience were the eligibility criteria. Participation was voluntary, and participants could withdraw from the study at any time. We conducted two online surveys using quota sampling by gender and age to capture specific demographic characteristics. The first survey (August–September 2023) included 600 participants, and the second (October–November 2023) included 400 participants. Demographic and digital health literacy data were also collected.

Data Analysis

Exploratory Factor Analysis (EFA)

With 600 participants, we performed the first EFA to explore the scale's factor structure and selected items using IBM SPSS Statistics for Windows, Version 25.0 (IBM SPSS Inc., Armonk, NY). Moreover, we conducted frequency analysis to verify demographic information and reliability analysis. Descriptive statistics are summarized as frequencies, percentages, or means (SD). The factor extraction method used was the maximum likelihood method with direct oblimin rotation to calculate factor loadings [31]. We preset the number of factors to five based on the literature review, which was verified using parallel analysis [32]. To ensure the item structure's validity, we followed factor analysis guidelines, removing items with factor loadings below 0.4 and items with cross-loadings above 0.3 on two or more factors [33]. The adequacy of the factor analysis was assessed using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity.

Additionally, we conducted a second EFA with a sample of 200 randomly selected individuals from

the entire pool of 400 participants in the second survey to validate the final items in the first survey. The EFA was conducted using the same method as in the first survey. As before, items with factor loadings below 0.4 and items with cross-loadings above 0.3 on two or more factors were removed to select the final items for the CFA.

Confirmatory Factor Analysis

To validate the scale structure, we conducted a CFA with 200 participants after the second EFA using IBM SPSS Amos for Windows, Version 25.0 (IBM SPSS Inc., Armonk, NY) and structural equation modeling (SEM). Model fit was evaluated using the chi-square statistic, Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Standardized Root Mean Square Residual (SRMR), and Root Mean Square Error of Approximation (RMSEA). A model with the ratio of the chi-square statistic to the respective degrees of freedom (χ^2/df) less than 3, CFI and TLI values greater than 0.90, and SRMR and RMSEA less than 0.08 was considered an acceptable fit. Additionally, convergent validity was assessed using Average Variance Extracted (AVE) values, ensuring that they were above 0.5, and Construct Reliability (CR) with values above 0.7. Discriminant validity was evaluated by comparing the square root of the AVE for each construct with the correlations between the constructs [34].

Results

Participants

The mean age of the sample was 63.63 years (SD = 5.26), and 50% were women. Further, 90.8% were married, and 4.0% were single. Regarding subjective economic status, 51.5% and 48.5% indicated that their economic position was above average and below average, respectively. Regarding subjective health status, 87.5% and 12.5% reported their health to be above average and below average, respectively. Participants provided demographic data encompassing gender, age, marital status, subjective economic situation, and subjective health status, along with digital health literacy items (Table 1).

First Validation Survey: Exploratory Factor Analysis

Based on the literature review and focus group interviews, we assembled a pool of 74 items reflecting the five factors of older adults' digital health literacy and extracted the underlying structure of items using EFA. In the first survey sample (600), all participants were aged 55–75 years, and 50% were women. The number of factors was determined using parallel analysis. The eigenvalues of the real data were more significant than those of the random data up to the fourth eigenvalue (real data eigenvalue = 0.461; random data eigenvalue = 0.334). However, from the fifth eigenvalue onwards, the eigenvalues of the real data were smaller than those of the random data (real data eigenvalue = 0.160; random data eigenvalue = 0.299).

Following the examination of item discrimination and determination of factor loadings, 29 items were retained. The domains of health information decision and utilization and sharing were consolidated, while other aspects remained. The KMO value, representing the suitability of factor analysis, was 0.981, and Bartlett's test of sphericity yielded a significant result ($\chi^2 = 19365.0$, $p < .001$), confirming the appropriateness of the model. The results also demonstrated a satisfactory level of internal consistency for each factor (Cronbach's alpha values: 0.925–0.944). Table 2 lists the selected components' commonalities and factor loadings.

We made minor adjustments to the working scale to align it with the conceptual framework of digital health literacy. First, the health information decision and utilization and sharing were combined to create a new factor called the utilization and decision of health information. Second, hospital apps were renamed health-related apps to encompass a broader range of applications. Finally, four new items related to digital health services were added. As a result, we created 33 items divided into 4 domains and their associated subscales (Supplementary Information).

Second Validation Survey: Exploratory Factor Analysis

We randomly selected 200 responses (women: 53.0%) from the 400 valid and unique responses in the second survey. Majority of the respondents were aged 55–65 years (51.5%). Of the 200 participants, 86.5% were married, 4% unmarried, and 9.5% divorced. The subjective economic level was categorized as high (1.0%), upper middle (10.5%), low middle (42.5%), or low (8.0%). Subjective health status was categorized into four groups: high (2.0%), upper middle (31.0%), low middle (10.5%), and low (0.5%).

The results of the secondary EFA also supported the feasibility of performing factor analysis (KMO

0.945; Bartlett test of sphericity: $\chi^2 = 4664.2$, $p<.0001$). Parallel analysis indicated that the four factors were consistent with the primary study. The fifth eigenvalue for the real data was 0.207, while that for the random data was 0.320. The internal reliability of each component and subscale was satisfactory, as indicated by the Cronbach α values for the four subscales falling between 0.91 and 0.96, which is above the minimum threshold of 0.7.

The first factor (utilization of digital devices) comprised 10 items and had a Cronbach α value of .96. The second factor (understanding health information) had five items and exhibited a reliability coefficient of .92. The third (utilization and decision of health information) and fourth factors (use intention) consisted of five items and demonstrated high reliability, with coefficients of 0.91 and 0.93, respectively. The 25-item scale demonstrated a high level of dependability with a value of 0.96. Almost all items had factor loadings above 0.6 (see Table 3). Overall, these results suggest that the four factors extracted through EFA were appropriate.

Confirmatory Factor Analysis

We performed CFA on a sample of 200 responses (women: 47.0%) that were not included in the prior EFA. Majority of respondents were aged 66–74 years, comprising 103 of 200 respondents (51.5 %). Of the 200 participants, 89.0% were married, 7.5% unmarried, and 3.5% divorced. Subjective economic level was classified into four categories: high (0.5%), upper middle (8.0%), low middle (40.5%), and low (, 8.5%). Subjective health condition was classified into four categories: high (4.0%), upper middle (32.5%), low middle (13.0%), and low (1.5%).

Following the outcomes of the previous EFA, four distinct factors were identified, and all 25 items were associated with each component. The scale fit indices were as follows: RMSEA was 0.088, with a 90% confidence interval (CI) of 0.080–0.096, and the SRMR value was 0.044. The CFI and TLI values were 0.924 and 0.916, respectively (Table 4).

The factor loadings per item in Table 5 were all greater than 0.7, indicating a strong relationship between the items and their respective factors. The AVE values were also higher than 0.7. Additionally, composite reliability values ranged from 0.93 to 0.96. Figure 2 displays the factor structure and standardized factor loadings obtained from the CFA, which demonstrated the validity of the scale developed in this study. The final scale comprised 4 factors and 25 items (Supplementary Information).

Discussion

Principal Results

This study aimed to develop and validate a scale for measuring digital health literacy. The only validated digital health literacy scale previously translated and validated in Korea was the eHealth Literacy Scale adapted by Ryu et al. in 2018 [35]. Despite its extensive translation and use in many countries [36], this scale does not keep pace with current technological development. We developed a Korean version of the Digital Health Literacy Scale (K-DHL) designed specifically for older adults who are vulnerable to the digital information divide. This scale comprises 25 items across 4 main factors: utilization of digital devices, processing of health information, utilization and reliability assessment of health information, and evaluation of usage intentions. The K-DHL scale considers various factors, making it a valuable tool for comprehensively assessing the digital health literacy level of older adults. Furthermore, it can serve as an essential foundational resource for developing digital health literacy education programs and applying patient-tailored digital therapeutic devices for older adults.

Utilization of Digital Devices evaluates the ability to search for and utilize health information using digital devices such as smartphones, tablets, and computers. Efficient digital device usage is essential for searching and utilizing health information, making it a fundamental element of digital health literacy. Studies have shown that older adults have lower skill levels in using the Internet to search for health information compared to younger people [37], with a lack of digital device proficiency cited as a primary cause. Therefore, assessing the utilization of digital devices on this scale can help develop tailored strategies for enhancing older adults' digital health literacy capabilities.

Understanding of Health Information measures the ability to understand and practically apply health information. Although many applications are available to assist individuals in health management, if users fail to comprehend basic health information, they will struggle to utilize these tools effectively, resulting in poor health management. Accurately measuring the ability to understand and apply health information based on this factor can serve as a starting point for improving digital health literacy.

Utilization and Decision of Health Information measures the ability to evaluate the reliability of health

information obtained through digital devices and apply it in practice. This is a crucial aspect of digital health literacy, as it includes the ability to use reliable information to engage with personal health information. For instance, it includes the ability to determine whether health information found on the Internet is for commercial purposes. Compared to younger people, older adults might find it more challenging to discern false information [38], which increases the risk of accepting incorrect health information. Given the vast amount of information available online, it is essential to identify the relevant information and that which contains evidence.

Finally, Use Intention measures an individual's intention to use digital health applications, that is the motivation and willingness to adopt and utilize new technologies, which are critical elements for enhancing an individual's digital health literacy level. One of the reasons older adults do not use digital devices is a negative attitude toward new technologies, such as a sense of resistance [39]. Consequently, older adults are slower to adopt new technologies, and even when educational programs are necessary, they may exhibit low learning motivation. For individuals with low intention to use digital health devices, it is critical to first raise awareness of the importance of digital health literacy and present convenient health services. This, in turn, will strengthen digital health literacy.

Digital health literacy significantly improves older adults' ability to manage their health and the effectiveness of digital healthcare services. This study highlights the importance of digital health literacy in South Korea's medical domain and provides fundamental data for addressing digital exclusion among older adults. Moreover, this study employed a distinct approach to assess the digital health literacy of older adults using the four key factors, distinguishing it from previous studies. This approach contributes to a more systematic understanding of digital health literacy and a more precise assessment of older adults' actual literacy levels.

Limitations

First, because data were collected through an online survey, it is possible that participation from older adults unfamiliar with digital devices was limited and resulted in an underestimation of the actual digital health literacy levels in groups with low literacy. Therefore, future studies should consider parallel offline

surveys for more accurate data. Second, this study focused on older adults, who are the most vulnerable to digital exclusion [13], which may limit the findings' generalization to other age groups or populations with diverse backgrounds. To achieve broader generalizability, future research should aim to collect samples that include a wider range of ages and backgrounds.

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Conflicts of Interest

None declared.

Summary

The study aimed to develop a scale for measuring digital health literacy among older adults by reviewing the literature, drafting items, and utilizing surveys for scale validation.

1. A two-step survey process involving 600 and 400 participants, respectively, was conducted to perform exploratory and confirmatory factor analyses.
2. The final scale included 25 items across four sub-factors related to the utilization and understanding of digital devices and health information, validated through rigorous statistical tests for reliability and structure.
3. This scale is intended to support targeted educational programs and treatments, thereby improving digital health literacy and healthcare access for older adults.

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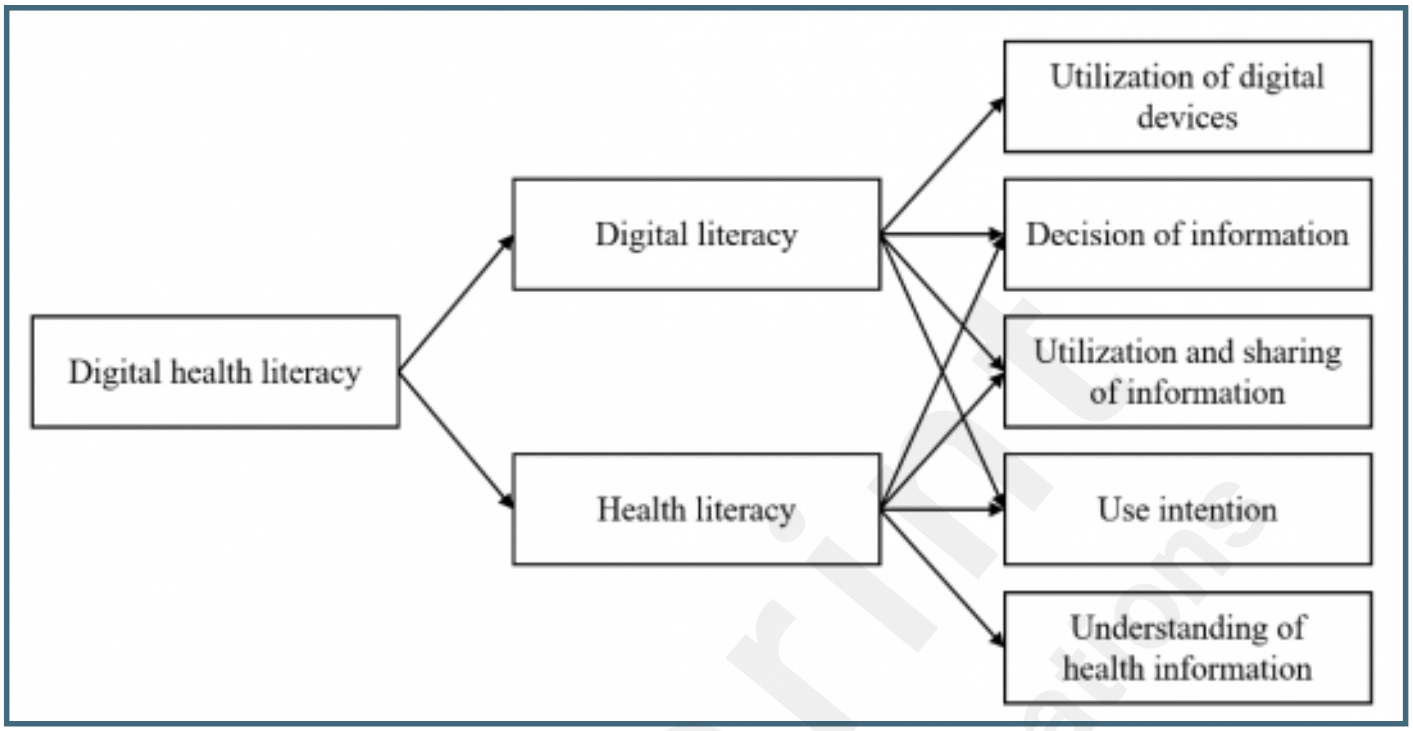
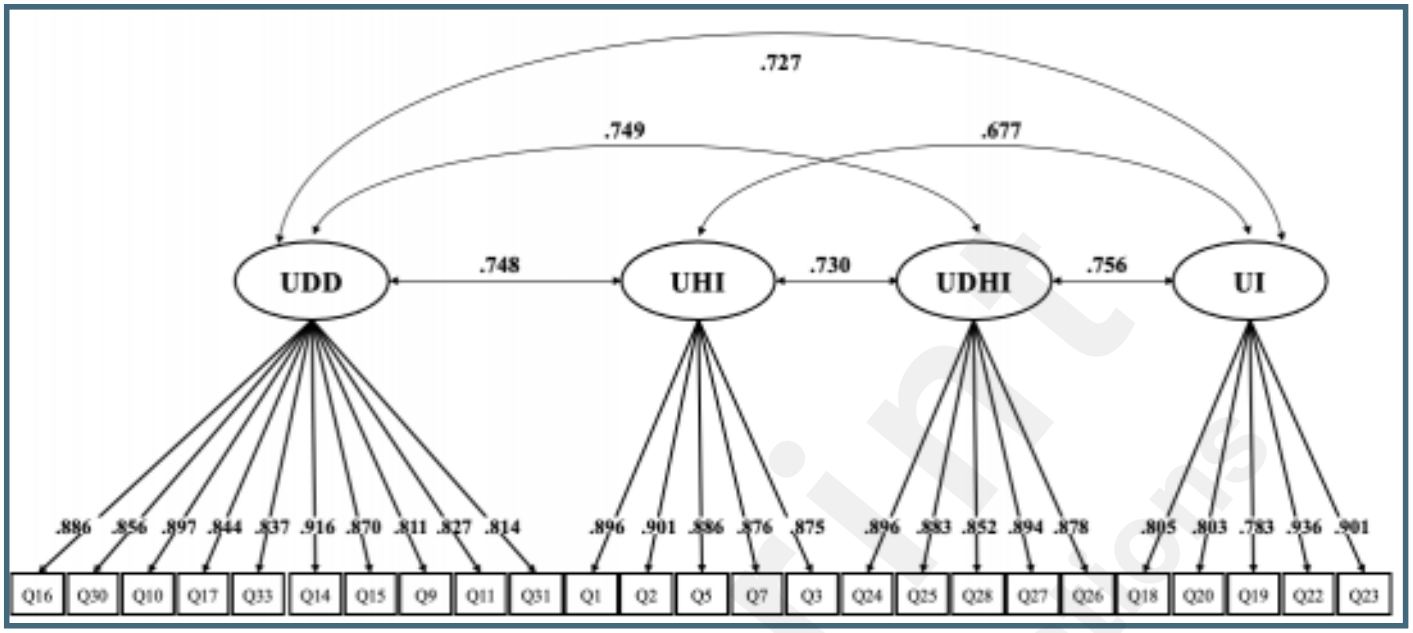
Supplementary Files

Figures

The Factor structure of digital health literacy.



Factor structure with standardized loading for K-DHL Scale. UDD: utilization of digital devices; UHI: Understanding health information; UDHI: utilization and decision of health information; UI: use intention.



Multimedia Appendixes

Preliminary Items for Digital Health Literacy Scale. 5-point Likert-scale. 0–4 (Strongly Disagree-Strongly Agree).
URL: http://asset.jmir.pub/assets/1402e9ebcc28339eedbaa4d713b7aac5.docx

Items of Digital Health Literacy Scale after first exploratory factor analysis. 5point Likert-scale. 0-4(Strongly Disagree-Strongly Agree).
URL: http://asset.jmir.pub/assets/be3a4a38d56f55c43c3f598f5b494961.docx

Digital Health Literacy Scale items after confirmatory factor analysis. 5-point Likert-scale. 0–4 (Strongly Disagree-Strongly Agree).
URL: http://asset.jmir.pub/assets/a50e92b6d814b6270473a2921fe4e77e.docx