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# Validation of the eHEALS-instrument in a restless legs syndrome population: A Classical Test Theory and Rasch Analysis study

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## *Abstract*

**Background:** An increased use of the Internet and digital healthcare for patients with long-term conditions implies a need for assuring digital health literacy skills. Patients with restless legs syndrome (RLS) is a group where digital sources of information are highly valued. This is due to a difficult diagnosis and complex treatment situation that contributes to patients seeking out online resources themselves to handle the perceived shortcomings in their care. To benefit from these resources, patients need to have the digital skills to explore information to optimize their understanding of the disease and its treatments. The eHealth Literacy Scale (eHEALS), which has been used in both general populations and patients with long-term conditions could, if proven valid, be used by researchers and clinicians to assess digital health literacy among patients with RLS to inform the development of patient-centered digital healthcare information and interventions.

**Objective:** To investigate the psychometric properties of eHEALS in patients with RLS to determine its adequacy and potential utility.

**Methods:** A cross-sectional design including patients with RLS from a national RLS patient organization was used. Data was collected via a mail-based survey comprising the following instruments: eHEALS, Restless Legs Syndrome-6 Scale (RLS symptoms), Pittsburgh Sleep Quality Inventory (sleep quality), Epworth Sleepiness Scale (daytime sleepiness), Patient Health Questionnaire-9 (depressive symptoms), and CollaboRATE (shared decision-making). Confirmatory factor analysis and Rasch models were used to assess the validity and reliability of the eHEALS. Measurement invariance, unidimensionality and differential item functioning across age, gender, medication use, sleep quality, level of depressive symptoms and participation in care decisions were assessed.

**Results:** A total of 788 patients with a mean (SD) age of 70.8 (11.3) years participated. Among the patients, 65% were females, 75% were married/living together, and 45% had attained a university education. A median eHEALS score (q1-3) of 28 (22, 33) was reported. The unidimensionality of the eHEALS was supported by the confirmatory factor analysis and Rasch model. The reliability of the eHEALS was confirmed using composite reliability and Cronbach's alpha. No differential item functioning was identified for age, gender, medication use, shared decision-making condition, depressive symptoms, or sleep quality meaning these have different probabilities of endorsing a given item on a multi-item scale after controlling for overall scale scores.

**Conclusions:** The eHEALS showed good validity and reliability and operated equivalently for male and female patients of different ages with various clinical- and treatment conditions related to RLS. Accordingly, healthcare professionals can use eHEALS as a psychometrically sound tool to explore digital health literacy level among patients with RLS.

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**6th of November 2024**

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## ABSTRACT

**Background:** An increased use of the Internet and digital healthcare for patients with long-term conditions implies a need for assuring digital health literacy skills. Patients with restless legs syndrome (RLS) is a group where digital sources of information are highly valued. This is due to a difficult diagnosis and complex treatment situation that contributes to patients seeking out online resources themselves to handle the perceived shortcomings in their care. To benefit from these resources, patients need to have the digital skills to explore information to optimize their

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**Results:** A total of 788 patients with a mean (SD) age of 70.8 (11.3) years participated. Among the patients, 65% were females, 75% were married/living together, and 45% had attained a university education. A median eHEALS score (q1-3) of 28 (22, 33) was reported. The unidimensionality of the eHEALS was supported by the confirmatory factor analysis and Rasch model. The reliability of the eHEALS was confirmed using composite reliability and Cronbach’s alpha. No differential item functioning was identified for age, gender, medication use, shared decision-making condition, depressive symptoms, or sleep quality meaning these have different probabilities of endorsing a given item on a multi-item scale after controlling for overall scale scores.

**Conclusions:** The eHEALS showed good validity and reliability and operated equivalently for male and female patients of different ages with various clinical- and treatment conditions related to RLS. Accordingly, healthcare professionals can use eHEALS as a psychometrically sound tool to explore digital health literacy level among patients with RLS.

**Keywords:** restless legs syndrome; health literacy; decisional conflict; shared decision-making; sleep; confirmatory factor analysis; validity

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## INTRODUCTION

Today there is an increased reliability on Internet and digital healthcare. About 5.4 billion people in the world, or 67% are Internet users (1) and in a highly IT dependent country like Sweden, this number is currently 95% of the population (2). In its Global Strategy on Digital Health 2020-2025, the WHO (3) stresses an increased importance of digital health and to deliver it with quality. Due to the increasing proportion of older people with long-term conditions requiring frequent care contacts, such as restless legs syndrome (RLS) (4), this means that understanding the individuals' ability to obtain specific knowledge about their disease diagnosis and its treatment via digital information channels becomes more important. The eHealth Literacy Scale (eHEALS) (5) is an instrument used to evaluate competence in health information seeking behavior both in the general population, as well as in patients with specific diagnoses. The eHEALS can be suitable for providing guidance to healthcare professionals regarding prerequisites for information seeking behavior (6) and digitally delivered healthcare interventions (7), but has not yet been psychometrically evaluated in patients with RLS.

RLS is a chronic disorder (4) where the patient has an irresistible need to move their legs and commonly suffers from poor sleep (8-10) and depression (11), with a significant impact on the whole life situation (12-14). Moreover, decreased physical function, lower general health, vitality, and quality of life (QoL) are described in comparison to the general population (15). According to a recent meta-analysis, RLS has a prevalence of 3% in the general population, and it is more common among women and elderly people (16). Some patients describe a prolonged period of symptoms before a diagnosis is made (13) which might be related to varied descriptions of symptoms (17, 18). A multiple pharmacological treatment strategy, including e.g., iron, α2δ channel ligands, and benzodiazepines (19) is often used together with dopaminergic drugs. Non-pharmacological therapies including self-care can also be applied, but evidence of their effectiveness is lacking (20-22). These diagnostic and treatment-related difficulties (23, 24) likely contribute to an increased desire among patients to seek RLS related information from online sources. Those with skills to identify relevant information (i.e., good health literacy) might improve their knowledge and insight before and after healthcare visits (13), which most likely can affect RLS patients view on shared decision-making of treatment (25) and in the long run treatment adherence.

E-health literacy is "the ability to seek, find, understand, and appraise health information from electronic sources and apply the knowledge gained to addressing or solving a particular health concern" (5). Shiferaw et al., (7) found both Internet use and eHealth literacy levels in patients with

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long-term conditions to be low and highlighted the importance to attend to this deficiency. Interestingly, Internet-delivered cognitive behavioral therapy interventions (ICBTs) have become popular since they can improve functioning in patients with conditions, such as chronic pain (26), asthma (27) and atrial fibrillation (28), where they also improved QoL (29). Face-to-face delivered CBT has in one recent RLS study (30) been found to decrease insomnia symptoms. Since cognitive behavioral therapy for insomnia is proven highly effective when delivered via the internet, this suggests ICBT as a potential complement to traditional pharmacological RLS treatment. However, if elderly patients with RLS are to use digital sources to either seek information about their disease condition or participate in ICBT it is vital that they possess health literacy and in particular eHealth literacy skills to ascertain use of these resources in an efficient, and purposeful manner. One initial step could be to consider the eHealth literacy level among patients with RLS with the use of the eHEALS (5).

The eHEALS has been used in patients with long-term conditions such as cancer (31-34) and rheumatic conditions (35). It has also been validated in general populations in Italian (36) and Portuguese (37), as well as in targeted cardiovascular disease populations in Persian (38), Norwegian (39, 40), and German (41). However, despite having been validated and proven useful in the above-mentioned general populations, as well as in various disease populations, eHEALS may not be applicable in patients with RLS, who are predominantly elderly, as no studies have explored its psychometric properties in this patient group. More specifically, it may be important to investigate subgroups of RLS patients. This entails those patients who report severe RLS symptoms, sleep disturbances and depressive symptoms, which have been found to affect cognitive ability (8), as they who suffer these symptoms may have a different likelihood to identify and understand health information from e.g., electronic sources (2). Patients with RLS, who have varied symptoms and where effective treatment is not always available or effective (24), often turn online for knowledge about their disease (13). If future dependency on digital health resources continues to increase, demanding adequate skills and abilities among users (2), knowledge about eHealth literacy measured with valid instruments for elderly patients with RLS will likely be important. As eHEALS is the most frequently used instrument to assess digital health literacy level and determine an patient's digital healthcare engagement (42) it warrants further investigation for this purpose in this specific patient group. The aim of the current study was to investigate the psychometric properties of eHEALS in patients with RLS to determine its adequacy and potential utility.

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# METHODS

## Study design and participants

A cross-sectional design was used including patients with RLS recruited from The Swedish RLS Association, a nationwide patient organization with 1500 members. Inclusion criteria for filling out the cross-sectionally administered postal survey consisted of 1) being 18 years old or more 2), diagnosed and treated for RLS 3) able to speak and understand Swedish and 4) provide a written informed consent. The study received ethical approval from the Swedish Ethical Review Authority (Dnr 2022-01515-01).

## Data collection

Information about the aim of the study was sent to the Swedish RLS Association board who allowed it to be shared with their listed members. To participate, eligible members had to return a written informed consent form and the completed survey in a pre-stamped envelope. Information provided by the participants also included their age, gender, employment, economic situation as well as years since their RLS diagnosis, self-reported co-morbidities and treatment.

# Instruments

## The eHealth Literacy Scale (eHEALS)

The eHEALS is a self-administered instrument that includes eight items scored on a 5-point Likert-type scale and was used to assess the level of eHealth literacy (5). The eight items determine the patient's ability to seek, find, evaluate and use digital information for decisions regarding their health. A Likert score of 1 signifies strongly disagree and 5 strongly agree. Scores range from 8 to 40 and the higher the score, the higher the level of the patient's eHealth literacy (5).

## Restless Legs Syndrome-6 Scale (RLS-6)

The well-validated RLS-6 was used to determine the severity of daytime and nighttime RLS symptoms. The six items involve sleep quality, RLS experiences during night and daytime, as well as during activity to differentiate RLS from other disorders (left out in scoring). Items are scored on a 0-10 scale with 0 being (no symptoms) and 10 (very severe symptoms). No total score is calculated (43).

## The Pittsburgh Sleep Quality Index (PSQI)

The well-established PSQI was used to assess sleep quality and sleep disturbances during the last month (44). It includes seven components with items involving a wide range of applicable indicators for evaluating sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleep medications and daytime dysfunction. To calculate PSQI global scores, the seven components are each rated from 0 to 3 points, stemming in a global score that ranges from 0 to 21 points. A score of ≥5 implies sleep difficulties (44). The PSQI has proven valid and reliable in patients with primary insomnia (45) and multiple sclerosis (46). PSQI can be used to distinguish sleep disorders (47).

**The Epworth Sleepiness Scale (ESS)**

The well-established ESS was used to determine the degree of daytime sleepiness. It includes eight different situations, all scored on a scale of 0-3, in which the patient's assesses the risk of dozing off or falling asleep. The total score range between 0 and 24 and a score ≥11 indicates excessive daytime sleepiness (48).

**Patient Health Questionnaire 9 (PHQ-9)**

The well-validated PHQ-9, a nine-item questionnaire, was used to determine depressive symptom severity. Each item is scored from 0 (not at all) to 3 (nearly every day). The cut off points that determine the level of severity ranging from mild to severe depressive symptoms are 5, 10, 15 and 20. The PHQ-9 score can range from 0-27 (49).

**CollaboRATE**

The CollaboRATE, a three-item instrument, was used to measure shared decision-making. The first item measures the effort made to help the patient to understand his/her health issues; the second the effort made to listen to what matters most to the patient about his/her health issues, and the third concerns effort made to include the patient in his/her future care. Each item is scored on a 5-point Likert scale where 1 signifies no effort was made and 5 that every effort was made (50). CollaboRATE has showed good validity and reliability in the context of RLS (25).

## Statistical Analysis

*Internal consistency*

Internal consistency was tested by computing Cronbach's Alpha (α) and McDonald's Omega (ω) as well as Composite Reliability (CR). Coefficients with values ≥0.70 indicated an acceptable level (51, 52). The internal consistency of the eHEALS was further assessed by calculating item-total correlation (corrected for overlap). The correlation coefficients ≥0.4 were considered acceptable.

*Construct validity*

Construct validity of the eHEALS was tested using confirmatory factor analysis (CFA) (53). Considering the nature of ordinal data with Likert response options (from 1 to 5), the diagonally weighted least squares (DWLS) estimation method was used in the CFA. Several model fit indices were used to evaluate the unidimensional structure in the CFA model; the chi-square ($\chi^2$), and degrees of freedom (df), the Root Mean Square Error of Approximation (RMSEA), Tucker–Lewis index (TLI), Comparative Fit Index (CFI), and standardized root mean square residual (SRMR). An acceptable CFA model fit has a CFI, and TLI value of 0.95 or higher, an RMSEA and SRMR value of 0.08 or lower, and a chi-square to degrees of freedom ratio ($\chi^2$/df) lower than 5 (54). The Average Variance Extracted (AVE) was calculated to assess the convergent validity of the eHEALS.

To make sure that the association between the latent structure of electronic health literacy and its eight items was equal across subgroups of patients (i.e., age and gender) measurement invariance was employed. A series of multiple groups of CFAs were conducted on the data to explore measurement invariance across the two given subgroups of patients (53). A hierarchical approach of measurement invariance was considered: at the fist level (the lowest restrictive model), configural invariance was examined, assessing whether the pattern of relationships between the eHEALS items and the factor was consistent across the groups. In the next level, metric invariance was conducted to determine whether the factor loadings were equal across the groups. In the last level (the heist restrictive level), scalar invariance was conducted to assess whether the item intercepts were equal across the groups. Measurement invariance was established if the differences between the hierarchical models were non-significant, as indicated by a non-significant of $\chi^2$ difference, ΔCFI <0.01, ΔRMSEA <0.03 and ΔSRMR <0.01 (55).

The psychometric properties of the eHEALS were further examined using Rasch analysis with the Rating Scale Model (RSM). To test item fit in the Rasch model, Infit and Outfit mean square (MNSQ) were used, with values between 0.7 to 1.3 indicating an acceptable range (56). To ensure that various subgroups of patients (i.e., age, gender, medication use, shared decision-making

condition (CollaboRATE), depressive symptoms (PHQ-9), and sleep quality (PSQI)) interpreted the items in eHEALS similarly, differential item functioning was conducted. A contrast >0.5 logit was considered substantial (57). All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS), Winsteps software version 4.3.0, and Jeffreys' Amazing Statistical Program (JASP) version 0.18.03.0.

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# RESULTS

## Study population

A total of 788 patients with a mean (SD) age of 70.8 (11.4) years responded (i.e., response rate of 52%). Among the patients, 65% were females, 75% were married/living together, and 43% had attained a university education. Additionally, 73% were retired. The mean time (SD) since being diagnosed with RLS was 16.4 (10.5) years. Of comorbidities hypertension (38 %) and cardiovascular disease (19 %) were the most common. Iron deficiency was reported by 10%, and 4% reported severe depressive symptoms. Dopamine agonists were the most common drugs used by 79% of the patients. Satisfaction with prescribed RLS treatment was reported by one-fifth. Regarding RLS symptom severity, 44% and 37% reported severe symptoms during night- and daytime, respectively, based on the RLS-6 questionnaire. A total of 43% experienced excessive daytime sleepiness. A median eHEALS score of 28 (q1-3; 22 - 33) was reported. Table 1 presents patient demographics and clinical characteristics.

**Table 1.** Sociodemographic characteristics of the population.

| Variables | Sample N = 788 |
|---|---|
| **Gender, female, *n* (%)** | 510 (65) |
| **Age, years, mean (SD)** | 70,8 (11,3) |
| **Civil status, Married/living together, *n* (%)** | 582 (75) |
| **Educational level *n* (%)**<br>**≤12-13 years/ ≥13 years** | <br>423 (55)/ 343 (45) |
| **Comorbidities, *n* (%)**<br>**Migraine**<br>**Iron deficiency**<br>**Hypertension**<br>**Cardiovascular disease**<br>**…Other** | <br>59(9)<br>78(11)<br>281(38)<br>143(19)<br>29(4) |
| **Pharmacological treatment, *n* (%)**<br>**Dopamine agonists**<br>**Opioids**<br>**$\alpha_2\delta$-ligands**<br>**Dopa/derivates**<br>**Iron supplement**<br>**Number of prescribed drugs, Md, q1, q3** | <br>625 (79)<br>163 (21)<br>144 (18)<br>105 (13)<br>33 (4)<br>3 (1, 5) |
| **RLS symptoms**<br>**RLS-6 Sleep quality, Md, q1, q3**<br>**RLS-6 RLS at nighttime, Md, q1, q3**<br>**RLS-6 Daytime RLS manifestations during relaxation, Md, q1, q3** | <br>11 (8, 14)<br>9 (6, 13)<br>4 (2, 7) |
| **Sleep**<br>**PSQI global score Md, q1, q3** | 12 (10, 14) |
| **Daytime sleepiness**<br>**ESS >10 (Excessive daytime sleepiness)** | <br>339 (43) |
| **Depressive symptoms** | |

| | |
|---|---|
| **PHQ-9 total score, Md, q1, q3** | 7 (4, 11) |
| **Shared decision making**<br>**CollaboRATE total score, Md, q1, q3** | 6 (3, 9) |
| **Competence in health information seeking**<br>**eHEALS total score Md, q1, q3** | 28 (22, 33) |

**Abbreviations:** eHEALS = eHealth Literacy Scale; ESS = Epworth Sleepiness Scale; PSQI = Pittsburgh Sleep Quality Inventory; PHQ-9 = Patient Health Questionnaire-9; RLS-6 = the Restless Legs Syndrome-6 Scale

## Internal consistency

The internal consistency, as measured by Cronbach's Alpha and McDonald's Omega and CR, was above 0.95. Moreover, the item-total correlations (corrected for overlap) were all above 0.840 (Table 2).

**Table 2.** Psychometric properties of the eHealth Literacy Scale (eHEALS) in scale level.

| **Psychometric testing** | **eHEALS** |
|---|---|
| Internal consistency (Cronbach's α) | 0.968 |
| Internal consistency (McDonald's omega ω) | 0.968 |
| Confirmatory factor analysis | |
| $\chi^2$ (*df*) | 52.583 (20) |
| Comparative fit index | 0.997 |
| Tucker-Lewis index | 0.996 |
| Root-mean square error of approximation | 0.047 |
| Standardized Root Mean Square Residual | 0.049 |
| Average Variance Extracted | 0.791 |
| Composite Reliability | |
| Item separation reliability from Rasch | 0.98 |
| Item separation index from Rasch | 6.28 |
| Person separation reliability from Rasch | 0.92 |
| Person separation index from Rasch | 3.32 |

*$P$<0.05

**Abbreviation**: df, degrees of freedom.

## Construct validity

The factor structure of the eHEALS, examined by the CFA, is provided in Table 2. The unidimensional structure of the eHEALS showed a very high model fit with $\chi2 = 52.583$, df = 20, $p < 0.001$; CFI = 0.997; TLI = 0.996; SRMR = 0.049, except for RMSEA = 0.047 (90% CI 0.031–0.062). All factor loadings were significant and ranged from 0.856 (item 7) to 0.920 (item 3).

The unidimensional structure of eHEALS was then further examined whether it could be interpreted similarly in different age and gender subgroups of the patients. As Table 3 shows, all items were perceived similarly by gender subgroups (a non-significant of $\chi^2$ difference, ΔCFI <0.01, ΔRMSEA

<0.03 and ΔSRMR <0.01). Although the $\Delta\chi^2$ test indicated a significant difference between the configural and metric models for age subgroups, the changes in CFI, RMSEA, and SRMR were all below the established thresholds for significance (i.e. ΔCFI <0.01, ΔRMSEA <0.03 and ΔSRMR <0.01).

**Table 3.** Measurement invariance of the eHealth Literacy Scale (eHEALS) across age and gender groups through confirmatory factor analysis.

| Model and comparisons | Fit statistics | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | $\chi^2$ (df) | $\Delta\chi^2$ (Δdf) | CFI | ΔCFI | SRMR | ΔSRMR | RMSEA | ΔRMSEA |
| **Gender** | | | | | | | | |
| M1: Configural | 55.339 (40) | | 0.998 | | 0.051 | | 0.032 | |
| M2: Metric | 60.995 (47) | | 0.999 | | 0.053 | | 0.028 | |
| M3: Scalar | 62.141 (54) | | 0.999 | | 0.048 | | 0.048 | |
| M2−M1 | | 5.656 (7) | | 0.001 | | 0.002 | | -0.004 |
| M3−M2 | | 1.146 (7) | | 0 | | -0.005 | | 0.02 |
| **Age** | | | | | | | | |
| M1: Configural | 56.817 (40) | | 0.998 | | 0.052 | | 0.034 | |
| M2: Metric | 72.931 (47) | | 0.998 | | 0.059 | | 0.038 | |
| M3: Scalar | 76.848 (54) | | 0.998 | | 0.054 | | 0.034 | |
| M2−M1 | | 16.114 (7) | | 0 | | 0.007 | | 0.004 |
| M3−M2 | | 3.917 (7) | | 0 | | -0.005 | | -0.004 |

**Abbreviation**: df, degrees of freedom.

Item fit statistics from the Rasch model are presented in Table 2. All Infit and Outfit mean square (MNSQ) values for the items were within the acceptable range: 0.75-1.21 for Infit MNSQ and 0.71-1.26 for Outfit MNSQ. Item 4 was reported to be the easiest item to interpret, while item 8 was perceived as the most difficult one.

The results of the differential item functioning analyses are presented in Table 4. No substantial

differential item functioning was found (i.e., contrast >0.5) across age, gender, medication use, shared decision-making condition (CollaboRATE), depressive symptoms (PHQ-9) or sleep quality (PSQI). However, item 8 showed a potential differential item functioning across sleep quality, indicating that those with sleep problems reported higher difficulty on item 8 compared to those without sleep problems (differential item functioning =0.51).

**Table 4**. Psychometric properties of the eHealth Literacy Scale (eHEALS) in item level.

| eHEALS | Factor loading[a] | Item-total correlation | Infit MnSq | Outfit MnSq | Difficulty | Correlation | SE | DIF across gender[bc] | DIF across age[bd] | DIF across medication use[be] | DIF across medication use[bf] | DIF across shared decision status[bg] | DIF across depression status[bh] | DIF across sleep quality status[bi] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Item 1** | 0.865 | 0.850 | 1.14 | 1.17 | -0.05 | 0.88 | 0.07 | -0.03 | -0.32 | 0.03 | 0.22 | -0.26 | 0 | -0.28 |
| **Item 2** | 0.900 | 0.885 | 0.88 | 0.87 | 0.02 | 0.90 | 0.07 | 0 | -0.14 | 0.22 | 0.27 | -0.07 | -0.02 | -0.19 |
| **Item 3** | 0.920 | 0.906 | 0.75 | 0.71 | -0.11 | 0.91 | 0.07 | 0.02 | 0 | 0.42 | 0.49 | 0 | -0.21 | 0.05 |
| **Item 4** | 0.884 | 0.869 | 1.15 | 1.09 | -0.81 | 0.88 | 0.07 | 0 | 0.54 | 0.04 | -0.27 | 0 | 0.17 | -0.10 |
| **Item 5** | 0.917 | 0.901 | 0.78 | 0.79 | -0.30 | 0.91 | 0.07 | 0 | 0.24 | -0.010 | -0.47 | 0.18 | 0.11 | -0.33 |
| **Item 6** | 0.901 | 0.882 | 0.93 | 0.93 | 0.05 | 0.90 | 0.07 | -0.06 | -0.09 | -0.82 | -0.64 | 0.17 | 0 | 0.20 |
| **Item 7** | 0.859 | 0.841 | 1.21 | 1.26 | 0.49 | 0.87 | 0.06 | 0.13 | -0.10 | 0.03 | 0.27 | -0.20 | -0.07 | 0.11 |
| **Item 8** | 0.868 | 0.851 | 1.10 | 1.13 | 0.71 | 0.88 | 0.06 | -0.11 | -0.06 | 0.13 | 0.06 | 0 | 0 | 0.51 |

**Abbreviations**: DIF, differential item functioning; MnSq, mean square error

[a] Based on confirmatory factor analysis.

[b] DIF contrast > 0.5 indicates substantial DIF.

[c] DIF contrast across gender=Difficulty for females-Difficulty for males.

[d] DIF contrast across age categories = Difficulty for patients with older than 70.79 years old-Difficulty for patients with equal and younger than 70.79 years old.

[e] DIF contrast across medication use=Difficulty for patients without medication use-Difficulty for patients with monotherapy.

[f] DIF contrast across medication use=Difficulty for patients without monotherapy -Difficulty for patients with polytherapy.

[g] DIF contrast across CollaboRATE total score: Difficulty for patients with SMD i.e., >6 - Difficulty for patients without SMD i.e., ≤6.

[h] DIF contrast across PHQ9 total score: Difficulty for patients with mild depressive symptoms i.e., >10 - Difficulty for patients without depressive symptoms vs mild depressive symptoms, ≤10.

[i] DIF contrast across PSQI total score: Difficulty for patients with sleep problems >5 - Difficulty for patients without sleep problems ≤ 5 MnSq = mean square error.

## Discussion

This is the first study that has investigated the psychometric properties of the eHEALS among patients with RLS. Our findings showed a unidimensional structure in both the CFA and the Rasch model with high fit. The unidimensionality was not affected by age or gender, as all items were perceived similarly by younger and older patients, as well as by women and men. Moreover, no

substantial differential item functioning was found across age, gender, medication use, shared decision-making condition, depressive symptoms, or sleep quality. Internal consistency also proved to be good. These findings support the use of a total score and that eHEALS can be an adequate tool to evaluate competence in health information seeking behavior in patients of different ages with various clinical- and treatment conditions related to RLS.

To begin with, a single factor solution has been found for eHEALS in several studies using general populations. Diviani et al. (36) found a single dimension for the Italian version in a community sample. Similarly, Milahe et al. (37), who translated the instrument into Portuguese, found excellent internal consistency for one dimension. However, studies focusing on different long-term conditions have reported various results. For example, Lin et al. (38), who used classical test theory and Rasch analysis in a cardiovascular disease population from Iran, found a single-factor structure. On the other hand, Richtering et al. (58) who used patients with moderate to severe cardiovascular disease found a good overall model fit, ordered response thresholds, reasonable targeting and good internal construct validity, but that eHEALS measured two constructs of eHealth literacy (i.e., using eHealth and understanding eHealth). Bauerle et al. (41) who evaluated the German version in patients with coronary heart disease and congestive heart failure confirmed the two-factor structure, construct and criterion validity, as well as measurement invariance at the scalar level for age, gender, and educational level. Finally, Brors et al. (40), who investigated the psychometric properties in Norwegian patients after a percutaneous coronary intervention for ischemic heart disease, also found a multidimensional construct. When comparing our construct validity to the above-mentioned studies who have validated eHEALS in various conditions, one might have in mind that aspects of importance for the ability to seek, find, understand, and appraise health information from electronic sources, may differ. These differences may be based on presence of sociodemographic factors, such as age, gender and education, as well as pathophysiological- and symptomatologic effects related to the actual condition. However, our finding of a unidimensional factor structure supports adding the scores of individual items to calculate a total score.

Secondly, as RLS patients in general are elderly (16) and often suffer from comorbidities, and report poor sleep and mood disturbances (8), as well as decreased QoL (15), it is vital to investigate differential item functioning. Importantly, our results showed no substantial differential item functioning for any of the items across age, gender, medication use, shared decision-making condition, depressive symptoms, and sleep quality, while item 8 showed potential differential item

functioning across sleep quality. However, the value of 0.51 was marginally above the threshold which gives a small probability that poor sleep quality will have a decisive importance for how the current question is answered. Even if the $\Delta\chi^2$ test indicated a significant difference between the configural and metric models for age subgroups, the model fit indices changes were all below the established thresholds for significance. Therefore, our findings indicate the psychometric properties for eHEALS to be acceptable, which implies it to be a useful tool for researchers and clinicians to measure digital skills, informational needs or self-care behaviors among patients with RLS. This has not been done in an RLS context, but digital skills that are deemed as important in general populations involve active information seeking, information utilization/sharing, and two-way interactive communication (59). Personal and socioeconomic factors, cultural factors, attitudes toward the Internet, as well as health status have also proven to be of importance for eHealth literacy. Moreover, improved health literacy has been associated with increased health interest, promotion of health behaviors and increased use of shared decision-making (59). Positive relationships have also been found between eHealth literacy and various healthcare processes (60). To foster digital behaviors for care in patients with RLS without knowledge of their eHealth literacy (i.e., to seek, find, understand, and appraise health information) might be difficult, especially since the disturbed sleep might cause decreased cognitive ability (13). However, utilizing digital technology in an optimal way can be a key to developing health skills (61), which in turn can facilitate the mastery of RLS symptoms.

Fitzpatrick, (61) stresses that digital tools such as eHEALS can facilitate patient education, self-care and provide empowerment possibilities. However, there are both facilitators and barriers for implementation of digital tools for older people, which has been proven in other long-term conditions. Factors that have been found to act as both facilitators and barriers involve demographic, social and socioeconomic factors, as well as health-related, dispositional, and technology-related factors (62). On the other hand, facilitators often concern active engagement of the end users in the design and implementation of an eHealth program, support for overcoming concerns, privacy and enhancing self-efficacy in the use of technology, and integration of the actual program across health services to accommodate the multimorbidity (63). Implementing digital technology into the available RLS care can, as shown in other patient groups (60, 61), probably lead to a transformation of healthcare delivery. Specifically, this may improve treatment options and communication among providers and patients (61), which in turn may give older patients with RLS improved involvement in their self-care, as well as in RLS-related clinical decision-making (25). However, studies on

general populations have found that barriers often relate to a lack of self-efficacy, knowledge, support, functionality, and information provision about the benefits of e-health (63). Challenges and limitations associated with digital health literacy often include issues related to access, reliability and privacy (61). Therefore, the above-described aspects need to be explored in an RLS context using various designs and instrumentation.

Shifting the focus towards RLS care delivered through the Internet, which patients today describe as a need (13), involves equipping them with digital skills to explore information to optimize their understanding of their disease, its pharmacological treatments and encouraging them to take an active role in managing their condition. However, obstacles when accessing digital health solutions concern technology literacy issues, affordability, the time burden to participate, and a perceived risk of losing in-person contact (64, 65). Studies have determined that involvement of user perspectives about what makes the best digital solution for those living with a chronic condition vary, but there is a strong conviction that tools providing feelings of reassurance increase the ability to manage their condition (64). Several studies, not performed on patients with RLS, highlight the need for co-designing digital health interventions (64, 65) as this is also particularly beneficial for providing more equitable access (64). Guidelines for RLS treatment provide information regarding pharmacological treatment (19). Non-pharmacological self-care interventions for RLS exist, and could be assessed (66), but are according to a meta-analysis by Harris et al. (20) seldom used and need more evidence. Tailored patient-centered digital healthcare interventions, informed by the eHEALS should be designed to promote digital health literacy at the individual and organizational level (65) to provide RLS patients with user-friendly eHealth solutions. In this way, digital health can thus both empower and motivate various parts of RLS treatment.

## LIMITATIONS

It is important to consider some methodological aspects. Even if the sample is relatively large, the predominance of female and elderly retired patients may have influenced response patterns of the survey, and the eHEALS as well. However, RLS is more common among women and older people (16), so our sample can be assumed to reflect the age and gender aspects of a clinical sample. Secondly, the data collection was conducted via the nationwide Swedish RLS patient organisation using a cross-sectional design, limiting the ability to perform test-retest analysis and explore changes in relation to different treatment interventions. Moreover, all assessments for differential item functioning were self-reported which might create recall bias. Future studies could use a prospective

design with repeated measurements to enable test-retest and assessment of reliability and competence in health information seeking behaviours predictive validity in relation to self-care activities among patients with RLS.

## CONCLUSION

This study showed promising psychometric properties for the eHEALS among patients with RLS. The instrument operated equivalently for male and female patients of different ages with various clinical- and treatment conditions related to RLS. Accordingly, healthcare professionals can use eHEALS as a psychometrically sound tool to explore digital health literacy level among patients with RLS.

## Data Availability

The datasets generated and analyzed for this study could be shared on reasonable request.

## Authors' Contributions

Information regarding contribution will be added after the review process.

Preprint JMIR Publications

## REFERENCES

1. International Telecommunications Union. ICT facts and figures 2023. Geneva: International Telecommunications Union (ITU); 2023.
2. The Internet Foundation in Sweden (IIS). Swedes and the internet 2024, Stockholm: The Internet Foundation in Sweden (IIS),; 2024 [updated Sep 30. Available from: https://www.iis.se/english/.
3. World Health Organization. Global strategy on digital health 2020-2025,. Geneva: World Health Organization,; 2021.
4. Allen RP, Picchietti DL, Garcia-Borreguero D, Ondo WG, Walters AS, Winkelman JW, et al. Restless legs syndrome/Willis-Ekbom disease diagnostic criteria: updated International Restless Legs Syndrome Study Group (IRLSSG) consensus criteria--history, rationale, description, and significance. Sleep medicine. 2014;15(8):860-73.
5. Norman CD, Skinner HA. eHEALS: The eHealth Literacy Scale. Journal of medical Internet research. 2006;8(4):e27.
6. Norman CD, Skinner HA. eHealth Literacy: Essential Skills for Consumer Health in a Networked World. Journal of medical Internet research. 2006;8(2):e9.
7. Shiferaw KB, Tilahun BC, Endehabtu BF, Gullslett MK, Mengiste SA. E-health literacy and associated factors among chronic patients in a low-income country: a cross-sectional survey. BMC medical informatics and decision making. 2020;20(1):181.
8. Trenkwalder C, Allen R, Högl B, Clemens S, Patton S, Schormair B, et al. Comorbidities, treatment, and pathophysiology in restless legs syndrome. Lancet Neurol. 2018;17(11):994-1005.
9. Padula WV, Phelps CE, Moran D, Earley C. Allocating provider resources to diagnose and treat restless legs syndrome: a cost-utility analysis. Sleep medicine. 2017;38:44-9.
10. Zhou X, Du J, Liang Y, Dai C, Zhao L, Liu X, et al. The Efficacy and Safety of Pharmacological Treatments for Restless Legs Syndrome: Systemic Review and Network Meta-Analysis. Front Neurosci. 2021;15:751643.
11. Lee HB, Hening WA, Allen RP, Kalaydjian AE, Earley CJ, Eaton WW, et al. Restless legs syndrome is associated with DSM-IV major depressive disorder and panic disorder in the community. J Neuropsychiatry Clin Neurosci. 2008;20(1):101-5.
12. Harrison EG, Keating JL, Morgan PE. The experience of living with restless legs syndrome: A qualitative study. J Health Psychol. 2021;26(8):1154-67.
13. Odzakovic E, Allgurin M, Jonasson LL, Öberg S, Fridlund B, Ulander M, et al. Experiences of facilitators and barriers for fulfilment of human needs when living with restless legs syndrome: a qualitative study. International journal of qualitative studies on health and well-being. 2024;19(1):2348884.
14. Knutsson S, Björk M, Odzakovic E, Hellström A, Sandlund C, Ulander M, et al. The ethos brief index-validation of a brief questionnaire to evaluate wellness based on a holistic perspective in patients with restless legs syndrome. Sleep & breathing = Schlaf & Atmung. 2024;28(4):1781-91.
15. Broström A, Alimoradi Z, Odzakovic E, Kaldo V, Jernelöv S, Lind J, et al. Quality of life among patients with restless legs syndrome: A systematic review and meta-analysis. J Clin Neurosci. 2024;122:80-91.
16. Broström A, Alimoradi Z, Lind J, Ulander M, Lundin F, Pakpour A. Worldwide estimation of restless legs syndrome: a systematic review and meta-analysis of prevalence in the general adult population. J Sleep Res. 2023;32(3):e13783.
17. Holzknecht E, Hochleitner M, Wenning GK, Högl B, Stefani A. Gender differences in clinical, laboratory and polysomnographic features of restless legs syndrome. J Sleep Res. 2020;29(3):e12875.

18. Holzknecht E, Domahs F, Brandauer E, Bergmann M, Zengin T, Delazer M, et al. Language analysis of spontaneous descriptions of restless legs syndrome: Gender differences? J Sleep Res. 2022;31(1):e13433.
19. Silber MH, Buchfuhrer MJ, Earley CJ, Koo BB, Manconi M, Winkelman JW. The Management of Restless Legs Syndrome: An Updated Algorithm. Mayo Clin Proc. 2021;96(7):1921-37.
20. Harrison EG, Keating JL, Morgan PE. Non-pharmacological interventions for restless legs syndrome: a systematic review of randomised controlled trials. Disabil Rehabil. 2019;41(17):2006-14.
21. Lv Q, Wang X, Asakawa T, Wang XP. Pharmacologic Treatment of Restless Legs Syndrome. Curr Neuropharmacol. 2021;19(3):372-82.
22. Bega D, Malkani R. Alternative treatment of restless legs syndrome: an overview of the evidence for mind-body interventions, lifestyle interventions, and neutraceuticals. Sleep medicine. 2016;17:99-105.
23. Garcia-Borreguero D, Cano-Pumarega I, Marulanda R. Management of treatment failure in restless legs syndrome (Willis-Ekbom disease). Sleep Med Rev. 2018;41:50-60.
24. Fulda S, Allen RP, Earley CJ, Högl B, Garcia-Borreguero D, Inoue Y, et al. We need to do better: A systematic review and meta-analysis of diagnostic test accuracy of restless legs syndrome screening instruments. Sleep Med Rev. 2021;58:101461.
25. Björk M, Knutsson S, Odzakovic E, Hellström A, Sandlund C, Ulander M, et al. Validation of two brief instruments (the SURE and CollaboRATE) to measure shared decision-making in patients with restless legs syndrome. J Sleep Res. 2024;33(4):e14071.
26. Terpstra JA, van der Vaart R, van Beugen S, van Eersel RA, Gkika I, Erdős D, et al. Guided internet-based cognitive-behavioral therapy for patients with chronic pain: A meta-analytic review. Internet Interv. 2022;30:100587.
27. Bonnert M, Särnholm J, Andersson E, Bergström SE, Lalouni M, Lundholm C, et al. Targeting excessive avoidance behavior to reduce anxiety related to asthma: A feasibility study of an exposure-based treatment delivered online. Internet Interv. 2021;25:100415.
28. Särnholm J, Skúladóttir H, Rück C, Klavebäck S, Ólafsdóttir E, Pedersen SS, et al. Internet-Delivered Exposure-Based Therapy for Symptom Preoccupation in Atrial Fibrillation: Uncontrolled Pilot Trial. JMIR cardio. 2021;5(1):e24524.
29. Särnholm J, Skúladóttir H, Rück C, Axelsson E, Bonnert M, Bragesjö M, et al. Cognitive Behavioral Therapy Improves Quality of Life in Patients With Symptomatic Paroxysmal Atrial Fibrillation. J Am Coll Cardiol. 2023;82(1):46-56.
30. Song ML, Park KM, Motamedi GK, Cho YW. Cognitive behavioral therapy for insomnia in restless legs syndrome patients. Sleep medicine. 2020;74:227-34.
31. Almoajel A, Alshamrani S, Alyabsi M. The Relationship Between e-Health Literacy and Breast Cancer Literacy Among Saudi Women. Front Public Health. 2022;10:841102.
32. Heiman H, Keinki C, Huebner J. EHealth literacy in patients with cancer and their usage of web-based information. J Cancer Res Clin Oncol. 2018;144(9):1843-50.
33. Fu M, Li A, Zhang F, Lin L, Chen C, Su Y, et al. Assessing eHealth Literacy and Identifying Factors Influencing Its Adoption Among Cancer Inpatients: A Cross-Sectional Study in Guangdong Population. Patient preference and adherence. 2023;17:1477-85.
34. Sözeri Öztürk E, Canbolat Ö, Polat Ü. Internet Use, eHealth Literacy, and Influencing Factors in Turkish Cancer Patients: A Descriptive and Correlational Study. Semin Oncol Nurs. 2023;39(4):151469.
35. Knitza J, Simon D, Lambrecht A, Raab C, Tascilar K, Hagen M, et al. Mobile Health Usage, Preferences, Barriers, and eHealth Literacy in Rheumatology: Patient Survey Study. JMIR mHealth

and uHealth. 2020;8(8):e19661.
36. Diviani N, Dima AL, Schulz PJ. A Psychometric Analysis of the Italian Version of the eHealth Literacy Scale Using Item Response and Classical Test Theory Methods. Journal of medical Internet research. 2017;19(4):e114.
37. Mialhe FL, Moraes KL, Sampaio HAC, Brasil VV, Vila V, Soares GH, et al. Evaluating the psychometric properties of the eHealth Literacy Scale in Brazilian adults. Rev Bras Enferm. 2021;75(1):e20201320.
38. Lin CY, Broström A, Griffiths MD, Pakpour AH. Psychometric Evaluation of the Persian eHealth Literacy Scale (eHEALS) Among Elder Iranians With Heart Failure. Eval Health Prof. 2020;43(4):222-9.
39. Dale JG, Lüthi A, Fundingsland Skaraas B, Rundereim T, Dale B. Testing Measurement Properties of the Norwegian Version of Electronic Health Literacy Scale (eHEALS) in a Group of Day Surgery Patients. Journal of multidisciplinary healthcare. 2020;13:241-7.
40. Brørs G, Wentzel-Larsen T, Dalen H, Hansen TB, Norman CD, Wahl A, et al. Psychometric Properties of the Norwegian Version of the Electronic Health Literacy Scale (eHEALS) Among Patients After Percutaneous Coronary Intervention: Cross-Sectional Validation Study. Journal of medical Internet research. 2020;22(7):e17312.
41. Bäuerle A, Marsall M, Jahre LM, Rammos C, Mallien C, Skoda EM, et al. Psychometric properties of the German revised version of the eHealth literacy scale in individuals with cardiac diseases: Validation and test of measurement invariance. Digital health. 2023;9:20552076231194915.
42. Faux-Nightingale A, Philp F, Chadwick D, Singh B, Pandyan A. Available tools to evaluate digital health literacy and engagement with eHealth resources: A scoping review. Heliyon. 2022;8(8):e10380.
43. Kohnen R, Martinez-Martin P, Benes H, Trenkwalder C, Högl B, Dunkl E, et al. Rating of daytime and nighttime symptoms in RLS: validation of the RLS-6 scale of restless legs syndrome/Willis-Ekbom disease. Sleep medicine. 2016;20:116-22.
44. Hinz A, Glaesmer H, Brähler E, Löffler M, Engel C, Enzenbach C, et al. Sleep quality in the general population: psychometric properties of the Pittsburgh Sleep Quality Index, derived from a German community sample of 9284 people. Sleep medicine. 2017;30:57-63.
45. Backhaus J, Junghanns K, Broocks A, Riemann D, Hohagen F. Test-retest reliability and validity of the Pittsburgh Sleep Quality Index in primary insomnia. J Psychosom Res. 2002;53(3):737-40.
46. Jerković A, Mikac U, Matijaca M, Košta V, Ćurković Katić A, Dolić K, et al. Psychometric Properties of the Pittsburgh Sleep Quality Index (PSQI) in Patients with Multiple Sclerosis: Factor Structure, Reliability, Correlates, and Discrimination. J Clin Med. 2022;11(7).
47. Beaudreau SA, Spira AP, Stewart A, Kezirian EJ, Lui LY, Ensrud K, et al. Validation of the Pittsburgh Sleep Quality Index and the Epworth Sleepiness Scale in older black and white women. Sleep medicine. 2012;13(1):36-42.
48. Johns MW. A new method for measuring daytime sleepiness: the Epworth sleepiness scale. Sleep. 1991;14(6):540-5.
49. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. J Gen Intern Med. 2001;16(9):606-13.
50. Barr PJ, Thompson R, Walsh T, Grande SW, Ozanne EM, Elwyn G. The psychometric properties of CollaboRATE: a fast and frugal patient-reported measure of the shared decision-making process. Journal of medical Internet research. 2014;16(1):e2.
51. Kalkbrenner MT. Alpha, omega, andH internal consistency reliability estimates: Reviewing these options and when to use them. Counseling Outcome Research and Evaluation. 2023;14(1):77.
52. Nunnally JC. Psychometric theory. New York: McGraw-Hill; 1978.
53. Brown TA. Confirmatory factor analysis for applied research. New York: The Guilford Press; 2015.

54. Schumacker RE, Lomax RG. A beginner's guide to structural equation modeling. New York: Routledge; 2010.
55. Cheung GW, Rensvold RB. Evaluating Goodness-of-Fit Indexes for Testing Measurement Invariance. Structural equation modeling. 2002;9(2):233-55.
56. Tesio L. Measuring behaviours and perceptions: Rasch analysis as a tool for rehabilitation research. J Rehabil Med. 2003;35(3):105-15.
57. Holland PW, Wainer H. Differential item functioning. In: Holland PW, Wainer H, editors. Differential item functioning. Hillsdale: Lawrence Erlbaum Associates; 1993. p. xv, 453 p.
58. Richtering SS, Morris R, Soh SE, Barker A, Bampi F, Neubeck L, et al. Examination of an eHealth literacy scale and a health literacy scale in a population with moderate to high cardiovascular risk: Rasch analyses. PloS one. 2017;12(4):e0175372.
59. Jung SO, Son YH, Choi E. E-health literacy in older adults: an evolutionary concept analysis. BMC medical informatics and decision making. 2022;22(1):28.
60. Refahi H, Klein M, Feigerlova E. e-Health Literacy Skills in People with Chronic Diseases and What Do the Measurements Tell Us: A Scoping Review. Telemedicine journal and e-health : the official journal of the American Telemedicine Association. 2023;29(2):198-208.
61. Fitzpatrick PJ. Improving health literacy using the power of digital communications to achieve better health outcomes for patients and practitioners. Front Digit Health. 2023;5:1264780.
62. Bertolazzi A, Quaglia V, Bongelli R. Barriers and facilitators to health technology adoption by older adults with chronic diseases: an integrative systematic review. BMC public health. 2024;24(1):506.
63. Wilson J, Heinsch M, Betts D, Booth D, Kay-Lambkin F. Barriers and facilitators to the use of e-health by older adults: a scoping review. BMC public health. 2021;21(1):1556.
64. Taylor ML, Thomas EE, Vitangcol K, Marx W, Campbell KL, Caffery LJ, et al. Digital health experiences reported in chronic disease management: An umbrella review of qualitative studies. J Telemed Telecare. 2022;28(10):705-17.
65. Palumbo R, Nicola C, Adinolfi P. Addressing health literacy in the digital domain: insights from a literature review. Kybernetes. 2022;51(13):82-97.
66. Odzakovic E, Sandlund C, Hellström A, Ulander M, Blom K, Jernelöv S, et al. Self-Care Behaviors in Patients with Restless Legs Syndrome: development and psychometric testing of the RLS-Self-Care Behavior Questionnaire (RLS-ScBq). J Sleep Res. Accepted 17102024. Article ID: JSR14390. DOI: 10.1111/jsr.14390