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Validation of eHealth Literacy Scale (eHEALS) on Sri Lankan Population of Working Age

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Abstract

Background: Electronic Health Literacy Scale (eHEALS) is a unidimensional measure defined by Norman and Skinner in 2006 that measures a person's ability to understand and use health information through electronic sources.

Objectives: This study aimed to evaluate the validity of eHEALS for working age employees in Sri Lanka.

Method: A cross-sectional study was conducted among managers and senior working age employees using a self-administrated eHEALS questionnaire. Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) was used to identify the behaviour of various eHEALS scales.

Results: Of 411 questionnaires distributed, 286 responses were returned. The results fit into a 2-factor model, indicating the division of eHEALS scales into 2 subscales with 64.493% of total variance. The factors were labelled as "Information Seeking" (eHEALS1-eHEALS5) and "Information Appraisal" (eHEALS6-eHEALS8) with internal consistency of 0.902 and 0.822 respectively. The Confirmatory Factor Analysis for the organization of 8 questions demonstrates high indices [minimum discrepancy per degree of freedom (CMIN/DF) = 2.215, goodness-of-fit index (GFI) = 0.969, comparative fit index (CFI) = 0.985, root mean squared error approximation (RMSEA) = 0.065)] and assures the convergent validity of eHEALS [(average variance extracted (AVE) values>0.5].

Conclusions: eHEALS is multidimensional as such that the first five questions and next three questions separately evaluate two dimensions of electronic health literacy of working age employees.

Keywords: *eHEALS, eHealth literacy scale, eHealth literacy, eHealth.*

INTRODUCTION

The continuous improvement and diffusion of medical knowledge has steered the populace to grasp that medicine alone cannot address health condition disparities among people [1]. This apprehension has ultimately shifted the accountability for one's own health, to oneself through healthy living. With the improvement of reach and richness of information through the internet, the conventional method of using health professionals as the elementary cause of health-related evidence has changed. The use of health-related material on the internet has become popular among different segments in society while coining the term 'electronic health (eHealth) literacy'. Among the various other literacies, eHealth illiteracy has been identified as one of the major barriers of adopting internet-based eHealth applications such as Telemedicine in several countries [2].

Electronic health literacy is initially delineated as the "ability to seek, find, understand, and appraise health information from electronic sources and apply

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the knowledge gained to addressing or solving a health problem" [3]. Considering literacies such as communicative, cultural, contextual and the contrast between propositional in addition to procedural literacies, eHealth literacy is redefined as "the ability to identify and define a health problem, to communicate, seek, understand, appraise and apply eHealth information and welfare technologies in the cultural, social and situational frame and to use the knowledge critically in order to solve the health problem" [4].

Self-efficacy theory and social cognitive theory that identify capabilities and self-assurance as predecessors to behaviour alterations and skill improvement have been considered as the foundation to build the "eHealth literacy" concept [5]. The "Lily Model" proposed by Norman & Skinner has been identified as the preliminary investigation into the construction of eHealth literacy [3]. Based on the Lily Model, a person to be literate in eHealth must have six base skills (or literacies) known as, health literacy, traditional literacy, information literacy, media literacy, scientific literacy, and computer literacy. Underlining literacies of this model were alienated into two central types that were recognized as "analytic" and "context-specific". The analytic literacies consisted of information, traditional, and media literacies whereas context-specific literacies consist of scientific, computer and health literacies [3]. Conventionally, the term literacy with languages has been delineated as the skill of using formal vocabulary, assiduously and mildly or the competence to peruse, write, to name the letters of in order, listen and to utter words or articulate sounds with the ordinary voice [6, 7]. This definition is followed by many authors to define traditional literacy [8]. The simplest form of literacy involves the ability to use language in its written form [9]. Consequently, when contextualizing the constructs of eHeath, health literacy can be delineated as a person's skill in finding, understanding, and applying health information [10, 11]. Listening and speaking abilities, numeracy competencies, reading and writing well and cultural and conceptual knowledge have figured as the capabilities associated with health literacy [12]. In addition, Nutbeam claimed that advanced cognitive skills, along with social skills, enables a person to captiously analyse facts [13]. Information literacy stands as a set of competencies an individual requires to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information [14]. In the viewpoint of a consumer, an information-literate person should be able to navigate to the exact information which satisfies his or her desire among a pool of information available in the World Wide Web using a search engine. Scientific literacy is the lore and understanding of scientific notions and procedures imperative for personal judgements, contribution to civic and cultural undertakings and economic endeavours [15]. Based on the explanations of A Framework for K-12 Science Education, the consumers who are in advanced stages of scientific literacy should be able to extrapolate science-based online health-related information; how it is done and how science actually works, better than a layman. This is further evident by the fact that Norman & Skinner states that, for those who lack enlightening experience or are open to scientific cogitation, might present a formidable challenge once they attempt to understand the health resources backed by scientific knowledge [3]. Media literacy on the other hand is defined as, the person's ability to develop metacognitive reflective strategies by means of study and critical responses towards the content of the media and its messages. Media literacy promotes reflective thinking and critical thinking of a person [3, 16]. Further, it has been identified as a capability to evaluate, access, and produce media in diverse forms and circumstances. Based on the way the media performs on those issues, the message that gets conveyed can change its shape. Therefore, the media skill or ability is commonly judged as an amalgamation of critical thinking proficiency and cognitive processes which persuade reflective thinking [16, 17]. The definition of computer literacy has been in debate for years. According to Computer Literacy USA (CL-USA) as cited in [18], computer literacy is delineated as an understanding of the concepts, terminology and operations that relate to general computer use. It is going beyond the competency to use computers ahead of solving problems or issues. The required functionality encompasses the capability to decipher and evade problems, acclimate to novel situations, preserve information systematized and communicate effectively with other computer-literate people as cited in [19]. Therefore, considering the ubiquity it generates, computer literacy has been considered as the grammar of the 21st century.

In the measurement of eHealth literacy of a person, the eHealth Literacy Scale (eHEALS) developed by Norman & Skinner stand ahead among other measurements [3]. Norman & Skinner's eHEALS is an 8-item criterion of eHealth literacy

which is shaped "to measure consumers' combined knowledge", consolation and perceived proficiency at finding, appraising and applying electronic health-related information to health challenges. The core skills that eHEALS assesses are health literacy, traditional literacy, information literacy, media literacy, scientific literacy, and computer literacy. All items in the eHealth Literacy Scale exercises a 5-point Likert scale respond to each question with responding options ranging from "strongly agree" to "strongly disagree".

Originally Norman & Skinner evaluated the properties of eHEALS psychometrically within the youth population aged 13 to 21years [3]. The exploratory factor loadings revealed that eHEALS produced one factor solution ranged from 0.60 to 0.84 factor loadings among the 8 items with 56% of the variance and internally consistent (α) of 0.88. In 2011, Van der Vaart and colleagues re-assessed the validity of the eHEALS using a Dutch translation among two population groups; patients who have rheumatic diseases and a stratified sample of the general Dutch population [20]. In both readings, the eight items were loaded on a single constituent which replicated the findings of Norman & Skinner [3]. Respectively 67% and 63% of variances were reported with α = 0.93 and 0.92. Chung & Nahm conducted a study in 2015 to assess the reliability and validity of eHEALS for older adults recruited online and found α = 0.94 and the exploratory factor analysis resulted in a single factor structure explaining 67.3% of the variance [21]. Furthermore, validity of the eHEALS has been assessed using Spanish University Students as a sample and confirmed the mono factorial structure of eHEALS through the exploratory factor analysis that explains 52.55% of the variance, with high factor loadings of the items [18]. This study resulted in a reliability of 0.87 and a test-retest correlation of 0.78. Similarly, a Japanese version of eHEALS (J-eHEALS) examined using 3,000 Japanese adults and found that J-eHEALS is a single factor solution and confirmatory factor analysis for the 8-items model which demonstrated high indices (GFI = 0.988, CFI = 0.993, RMSEA= 0.056)" with α = 0.93[22]. Nguyen and colleagues [23] examined the psychometric validity and reliability of eHEALS with two adult populations using the Rasch model and found that more than 90% of respondents; university students and adults who use the internet, two samples were fitted to the model and none of the items were outright or mis fitting. Also, supporting the criterion of uni-dimensionality, EFA presented in Nguyen et al. study items of eHEALS loaded on a single factor solution [23]. Changing the direction of thinking, a research done by Neter and colleagues in Israel using 819 households has scrutinized the dimensionality of eHEALS, from the standpoint of cognitive skills. Their findings were in contrast to Norman & Skinner [3] findings, as they identified the 2-factor structure for eHEALS with higher internal consistency (α = 0.83 and = 0.83) and factor loadings above 0.48[24].

Furthermore, Van der Vaart, et al. proved that the validity of eHEALS instruments is questionable though eHEALS yielded a single factor in a principal component analysis with a higher level of internal consistency [20]. Thus, the theoretically grounded fact of uni-dimensional nature of eHEALS is proven to be wrong in some instances as it provides reasons to be multi-dimensional. This opens the ground to investigate the dimensionality of eHEALS using different populations. However, an investigation of the scale with the working age population in a developing country has not been done so far. Therefore, this study aims to assess the validity of electronic health scale among the working age population in Sri Lanka.

MATERIAL AND METHODS

Sample

National Survey on Self-Reported Health in Sri Lanka, (2014), revealed that Senior Officials and Managers are highly susceptible to non-communicable diseases such as Diabetes and high blood pressure (HBP) compared to other groups in the working age population. Hence, Senior Officials and Managers were selected as the population in this study. Based on the results of the last Labour Force Survey in Sri Lanka (2015 1st Quarter), there were 480,086 Managers, Senior Officials and Legislators employed in Sri Lanka. Keeping this as the baseline population and following the rule of Krejcie & Morgan [25], a sample of 384 Managers and Senior Officials were identified as adequate sample size for the study. Accordingly, 411 questionnaires were distributed between July and November 2018 using convenient sampling techniques and was able to collect 287 filled questionnaires back. In the data pre-processing stage, one questionnaire was left out due to incompleteness. Consequently, 286 responses were eligible for the final analysis.

Instrument

A self-administered appraisal questionnaire was used in this study. The questionnaire comprised two sections. The first section consisted of questions relating to demographic variables (gender, age, marital status, education and income) and the second section contained questions of the traditional eHEALS questionnaire. The traditional eHEALS questionnaire comprises eight questions that allow respondents to select an answer from 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). The data was collected both through online and paper-based surveys.

Statistical Analysis

Distributional properties of the data were assessed via skewness, kurtosis, and floor/ ceiling effects. If skewness and kurtosis values of eHEALS lie between ±1, it is "assumed to indicate no or slight non-normality" [20]. If 15% or more respondents reached the lowest (eight) or highest (forty) possible score of eHEALS, floor or ceiling effects are considered to be present [26].

Internal consistency was measured using Cronbach's coefficient alpha. The higher the Cronbach's coefficient alpha, the better the measuring instrument is accepted [28]. Exploratory factor analysis (EFA) was conducted using SPSS version 21.0 for Windows [27]. Factor analysis refers to a statistical technique that used to simplify complex sets of variables (facts) [30]. It also used as a multivariate technique that describe the variability of observed correlated variables in terms of lower number of unobserved variables (factors)[36]. "Maximum likelihood factoring estimation via the Promax rotation as the oblique rotation method was employed" [29]. According to Kline, item communalities over 0.3 can be accepted [30]. If orthogonal factor loadings were greater than 0.71, it is rated as "excellent" and if greater than 0.63, as "very good" [31]. Confirmatory factor analysis was conducted using Amos Version 18.0[32].

RESULTS

Sample Description

The selected sample consisted of 63% of male and 37% female managerial level employees. This is similar to the Sri Lankan country profile where as per the Sri Lanka Labour Force Survey (2015 1st Quarter) - employed person by occupation group (Based on ISCO 08) there are 334,507 (70%) male managerial level employees and 145,579 (30%) female managerial level employees in Sri Lanka. In the context of age category, the majority of the managerial level employees (52.8%) were in the 30-39 age category. In addition to this, the sample comprised 68.9% married and 26.9% unmarried managerial level employees. From the education perspective, the sample comprised 19.5% managerial level employees who have completed their Diploma or secondary education (Advanced level examinations) and 79.5% had Bachelor's Degree or above. When considering their combined monthly income 40.2% earned LKR 100,000 or above. The mean income of the group was LKR 75,000 to LKR 100,000.

Distributional Properties

eHEALS' aggregate scores were in the region of normality (approximately normally-distributed) with skewness of -.200 to +.309 (SE = 0.144) and kurtosis of -.790 to -.611 (SE = 0.287). No participant scored the worst possible score (eight), but 15 (5.2%) participants scored the best possible score (forty). Findings conclude that floor and ceiling effects were not present.

Exploratory Factor Analysis (EFA) of eHealth Literacy

Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was .884 and Bartlett's test of sphericity was significant (χ^2 (28) = 1371.359, $p < 0.05$) which denotes a meritorious sample of adequacy for a variable in the model for factor [33].

As per the extraction results, communalities ranged from 0.581 to 0.706 (Table 1). 64.493% of total variance is divided among the two factors (Table 2). On the other hand, according to the residuals which were computed between observed and reproduced correlations, three (03) non-redundant residuals with absolute value greater than 0.05 were identified which represented 10.0% of it. Below 5% of non-redundant residuals are accepted in EFA. As shown in the pattern matrix (Table 1) two separately correlated factors have been identified. Overall loading values of the factors were higher than 0.628 which indicates a very good fit. Reliability turned out to be high with Cronbach's α of .902 for eHEALS1- eHEALS5 and .822 for eHEALS6 – eHEALS8.

Table 1: Communalities and Pattern Matrix - eHealth Literacy

		Communalities		Factor		Item – total correlation	Reliability
		Initial	Extraction	1	2		
eHEALS1	I know how to find helpful health resources on the Internet	.616	.656	**.877**		.683	
eHEALS2	I know how to use the Internet to answer my health questions	.632	.677	**.865**		.712	
eHEALS4	I know what health resources are available on the Internet	.606	.616	**.810**		.722	**.902**
eHEALS3	I know where to find helpful health resources on the Internet	.684	.706	**.702**		.754	
eHEALS5	I know how to use the health information I find on the Internet to help me	.620	.643	**.628**		.753	
eHEALS7	I have the skills I need to evaluate the health resources I find on the Internet	.452	.581		**.831**	.561	
eHEALS6	I can tell high quality from low quality health resources on the Internet	.566	.677		**.749**	.702	**.822**
eHEALS8	I feel confident in using information from the Internet to make health decisions	.507	.603		**.743**	.650	

Extraction Method: Maximum Likelihood a. Rotation converged in 3 iterations.

Table 2: Total Variance Explained - eHealth Literacy

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	4.795	59.934	59.934	4.442	55.526	55.526	4.126
2	1.084	13.555	73.489	.717	8.967	**64.493**	3.470
3	.511	6.394	79.883				
4	.430	5.380	85.263				
5	.387	4.835	90.097				
6	.341	4.262	94.359				
7	.238	2.975	97.335				
8	.213	2.665	100.000				

Extraction Method: Maximum Likelihood.

Confirmatory Factor Analysis (CFA) of eHealth Literacy

The outcomes of CFA were used to ensure the convergent and discriminant validity of theoretical constructs in the model. Figure 1 shows the CFA measurement model used for eHealth Literacy.

eHealth Literacy model measure of fit, CMIN/DF strands at 2.215 indicates healthy model. GFI = 0.969 and adjusted goodness of fit (AGFI) = 0.934 which indicate acceptable model fit. Root mean square residual (RMR) = 0.027, normed fit index (NFI) = 0.973 and comparative fit index (CFI) = 0.985 indicated generally satisfied validity evaluation standards. Particulars are presented in Table 3. Average variance values were greater than 0.5 which indicates the convergent validity in the model.

Table 3: Index of Fit of the Model

Chi-Square	(df)	P	CMIN/DF	GFI	AGFI	NFI	CFI	RMSEA
37.659	17	.003	2.215	.969	.934	.973	.985	.065

DISCUSSION

Based on the content and phraseology of the eHEALS items, we confirmed the multidimensional structure of Norman and Skinner's eHEALS items[3] in relation to working age population with two dimensions namely, "Information Seeking" (eHEALS1- eHEALS5) and "Information Appraisal" (eHEALS6 – eHEALS8). The findings of this research aligned with the findings of Neter, et al.[24]. Though both studies showed the availability of two factors, in this research the two factors were loaded with slightly different items compared to Neter, et al. [24]. However, findings of this study were closer to the findings of Soellner, et al. [12]. Soellner, et al. [12] stated slightly different factor loadings to our findings as they label Information Seeking when item 1 to 5 and 8 of the original scale (eHEALS 1- eHEALS5 and eHEALS8) are loaded together. Further, Soellner, et al.[12] labelled Information Appraisal when items 6 and 7 of the original scale (eHEALS 6 and eHEALS7) are loaded together.

With the support of the previous findings, Information Seeking can be defined as a cognizant exertion to gain facts in retort to a demand or lacuna in human's lore [34]. Moreover, the Information Appraisal is an evaluative process that reflects the person's subjective interpretation of the event [35].

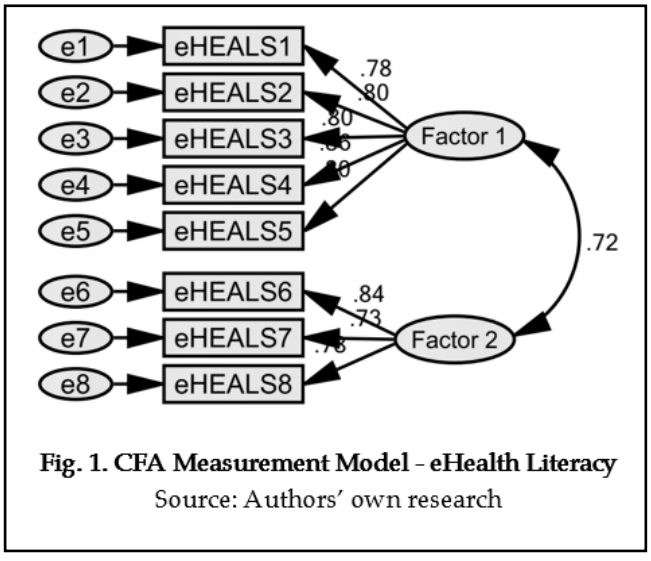

Fig. 1. CFA Measurement Model - eHealth Literacy
Source: Authors' own research

Accordingly, item 1 to item 5 of the original scale (eHEALS1- eHEALS5) described the deliberate and intended effort to get health-related information by using diverse sources. According to Viswanath et al. [34], appraisal of health information from mass media is of greater influence to a persons' health-related attitudes or behaviours. Consequently, item 6 to item 8 of the original scale (eHEALS6- eHEALS8) describe the skill of subjective interpretation and use of health-related information sufficiently. Furthermore, based on the factorial structure and factor loading of previous findings [12], eHEALS8 was loaded with comparatively a lower loading (0.580) than other items. However in our study, it clearly shows that the item 8 (eHEALS8) could be categorised as Information Appraisal factor with adequate factor loading (0.743). When analysing the factor structure, the content, wording of the items and statistical findings, we see that factor eight had better loadings with Information Appraisal. While confirming the validity of our findings, we believe that Soellner, et

al.[12] may have got such results with such item arrangement due to the use of German translated version of eHealth literacy scale (G- eHEALS).

When assessing the reliability of two factors in this study, reliability of factor 1 in our study is higher than Norman & Skinner [3], yet similar to Van der Vaart, et al. [20]. Factor loadings in our study ranged between 0.628 - 0.877 which are similar to Norman & Skinner [3]. However, our study reported a higher variance between items than the study done by Norman & Skinner [3].

CONCLUSION

Our study confirmed that Norman & Skinner's electronic health scale (eHEALS) is multidimensional in relation to the working age population in Sri Lanka. The first five items of eHealth literacy scale loaded to factor 1 (label as "Information Seeking") while the last three items remained with factor 2 (label as "Information Appraisal"). The factor loading reliability and variance are adequate to confirm the decision. In conclusion, we propose that eHEALS could be identified not only as a measure of health literacy of an individual, but also as an effective instrument that allows to take decisions on electronic health related knowledge and ability of an individual.

RECOMMENDATION

We would like to recommend the use of eHealth survey with eHEALS to be used to understand the health Information Seeking and Information Appraisal behaviour of working age persons.

LIMITATIONS

The research questionnaire was in the original language (English) and was not translated to participants' native languages. Thus, our findings are applicable to working age Managerial and Senior Level employees who have a good level of English language literacy.

Author declarations

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Availability of data and materials
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Ethics approval and consent to participate
The study was conducted under the approval of the Management Board of study, USJ. The questionnaire required participants perceptions anonymously and kept all responses confidential

Competing interests
The authors have no conflicts of interest to declare

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