

The dimensionality of health literacy and eHealth literacy

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Health literacy is both a personal asset and a risk factor (Nutbeam, 2008).

It is defined by the World Health Organization (WHO, 1998) as "the cognitive and social

skills which determine the motivation and ability of individuals to gain access to, understand and use information in ways which promote and maintain good health" (WHO, 1998). Nutbeam (2000) further elaborated and suggested the construct included functional (i.e., basic reading, writing, numeracy skills), interactive and critical skills. Health literacy was found to be a major predictor of adverse health outcomes (e.g., Baker et al., 2007; Dewalt et al. 2007; Schillinger et al. 2002; Yin et al. 2007), with outcomes ranging from difficulty following medication instructions, to applying for benefits and to all-cause mortality.

The Internet-era equivalent to health literacy is eHealth literacy, which includes basic literacy as well as information, media, health, computer and scientific literacies (the Lily model, Norman & Skinner, 2006). eHealth literacy was also found to be associated with more effective contact with the attending physician, enhanced use of medical insurance, self-management of health needs and higher perceived understanding of a disease/condition (Neter & Brainin, 2012).

Assessment of Health literacy and eHealth literacy

Health literacy is measured both through performance and self-report. Screening tools for clinical settings such as Shortened Test of Functional Health Literacy in Adults (S-TOFHLA) (Parker, Baker, Williams, & Nurss, 1995), Rapid Estimate of Adult Literacy in Medicine (REALM) (Davis et al., 1993) and Newest Vital Sign (NVS) (Weiss et al., 2005) measure performance, focusing on domains that are thought to be markers of an individual's overall capacity (Baker, 2006). Comprehensive measures such as the Health Activity Literacy Scale (HALS) (Rudd, Kirsch, & Yamamoto, 2004) that include tasks in various health domains (health promotion, protection, maintenance, disease prevention, system navigation) also exist, yet a recent review on the use of health literacy measures (Mackert, Champlin, Holton, Munoz, & Damasio, 2014) found low use of these measures and called for the development of measures that can be administered remotely online. Such self-report measure that relates both to the above health domains and also to the cognitive skills involved - seeking, understanding (basic literacy and numeracy), evaluating and applying health information - was recently developed and tested in several European countries (Sorensen et al., 2012; European Health Literacy Scale (HLS-EU) project).

eHealth literacy is assessed most often by the self-report measure eHEALS (Norman & Skinner, 2006). The measure focuses on finding information on the Internet and assessing it.

Norman and Skinner (2006) found that the measure consists of one factor in an exploratory factor analysis, but recent work (Soellner, Huber, & Reder, 2015) uncovered 2 factors: seeking and appraising.

Present work

The present report examined the dimensionality of the HLS-EU and eHEALS, from the perspective of the cognitive skills required in health literacy and eHealth literacy (rather than health domains). The hypotheses were that the HLS-EU had a structure of 3 factors: seeking, understanding and evaluating/applying; that the eHEALS had a 2-factor structure of seeking and appraising, and lastly that these concepts are distinct and are moderately correlated.

Methods

Data collection and sample characteristics

Data analyzed in this report was collected from a nationally representative random-digital-dial (RDD) telephone household survey of Israeli adult population (21 and older) conducted in November 2014 (landlines and mobile combined).

The sampling procedure through which the RDD worked (landlines only) began by dividing statistical areas into four layers according to: (a) population groups, geographical districts, different sizes of settlements (big cities to small towns and villages), and social economic status index based on the Israeli Central Bureau of Statistics classification. Sampling employed a dual-frame design, incorporating two selection stages without stratification in either frame. The larger frame was designed to provide national coverage of the eligible population. Calls were

placed to 1789 residential households to identify 1628 eligible potential respondents, of whom 819 agreed to be interviewed, representing 50.3% response rate. The interviewers conducted the telephone survey using CATI (Computer Assisted Telephone Interviewing) software.

Measurements (only some of the survey is described below)

Health Literacy (perceived) was assessed by the European Health literacy Scale (HLS-EU) (Sorensen et al., 2012, 2013). The 15-item short version of the scale was used. The scale was translated and validated by Levin-Zamir and Baron-Epel (2013), using a 16-item questionnaire, and 1 item was deleted in the pilot stage of the present administration due to comprehension problems of respondents.

eHealth Literacy was assessed by the eHEALS tool (Norman & Skinner, 2006). The scale comprises of eight items on a 5-point Likert scale (1 = strongly disagree, to 5 = strongly agree). The scale was previously translated to Hebrew (Neter & Brainin, 2012).

Socio-demographic information on age, gender, education, ethnicity, country of birth, self-rated health and the existence of chronic conditions was obtained as part of the background variables.

Data analysis

Confirmatory factor analysis was carried out with SAS v. 9.4 and MPLUS v 7.31 (Muthén & Muthén, 2010). Quality of model adjustments were made through the following fit indices: Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI), with reference values of adjustment above 0.90; Parsimony CFI with acceptable values above 0.06; Root Mean square Error of Approximation (RMSEA) below 0.05, and Akaike Information Criterion (AIC). The reference values

are accordingly to those suggested by Kline (2011). Items' individual reliability was assessed through squared multiple correlation ($R^2 > 0.20$).

In order to assess the dimensionality of the constructs, Confirmatory Factor Analysis (CFA) was computed for 2 different models in each of the constructs. The first model for the two constructs included only one factor. The second model of health literacy included 3 latent variables (seeking, understanding, and appraising/ applying) and that of eHealth literacy included 2 latent variables (seeking and appraising).

Results

Preliminary analysis on the scales' reliability

showed that the internal consistency of the total scales was 0.86 and 0.89 for health literacy and eHealth literacy, respectively.

Model comparisons indicated that the initial one-factor model had a poor fit for both scales: ($\chi^2(909) = 914.395$, $p = 0.000$; CFI = 0.659; RMSEA = 0.106, $P(\text{rmsea} < 0.05) = 0.000$; AIC = 23570.648) for health literacy and ($\chi^2(20) = 145.550$, $p = 0.000$; CFI = 0.873; RMSEA = 0.126, $P(\text{rmsea} < 0.05) = 0.000$; AIC = 7953.155) for eHealth literacy.

The 3-factor model for health literacy presented good fit indices: $\chi^2(87) = 213.502$, $p = 0.000$; CFI = 0.948; RMSEA = 0.042, $P(\text{rmsea} < 0.05) = 0.000$; AIC = 22630.309. The items of the health literacy scale, along with standardized factor loading, are presented in table 1. One item had low loading (on factor 1) and R^2 and was later

Table 1

Standardized Factor loadings in Confirmatory Factor Analysis (CFA) and R^2 of Health literacy items ($n = 816$)

Item	Factor 1	Factor 2	Factor 3	R^2
Find information on treatments of illnesses that concern you	0.681			0.464
Find information on how to manage mental health problems like stress or depression	0.689			0.474
Find out about activities that are good for your mental well-being (meditation, exercise, walking, Pilates etc.)	0.725			0.526
Find out where to get professional help when you are ill *	0.362			0.131
Understand your doctor's or pharmacist's instruction on how to take a prescribed medicine		0.819		0.671
Understand what your doctor says to you		0.859		0.737
Understand information in the media on how to get healthier		0.723		0.523
Follow instructions from your doctor or pharmacist?			0.582	0.399
Use information the doctor gives you to make decisions about your illness			0.609	0.371
Judge when you may need to get a second opinion from another doctor		0.558		0.311
Understand health warnings about behavior such as smoking			0.672	0.452
Understand why you need health screenings			0.672	0.451
Judge which everyday behavior is related to your health (drinking and eating habits, exercise etc.)			0.758	0.575
Decide how you can protect yourself from illness based on information in the media			0.598	0.358
Understand advice on health from family members or friends			0.618	0.382

Note. *item removed from further analyses

removed from further analyses. When the model for health literacy was collapsed into 2 factors (combining two factors), the fit indices were poor: χ^2 (89) = 377.125, p = 0.000; CFI = 0.063; RMSEA = 0.106, $P(\text{rmsea} > 0.05)$ = 0.001; AIC = 22850.693), as well as when the model was collapsed into one factor: (χ^2 (90) = 914.352, p = 0.000; CFI = 0.659; RMSEA = 0.106, $P(\text{rmsea} > 0.05)$ = 0.000; AIC = 23570.648). Reliabilities were calculated for each factor in the final 3-factor model: seeking, α = 0.72, understanding, α = 0.85, and appraising/applying, α = 0.83. Correlations between seeking and understanding was 0.38, between understanding and appraising/applying was 0.41, and between seeking and appraising/applying 0.56. Finally, the R^2 of individual items ranged from 0.382 to 0.478.

The 2-factor structure for eHealth literacy, as found by Soellner et al. (2015), was tested on the sample and yielded a poor fit: χ^2 (19) = 135.164, p = 0.000; CFI = 0.882; RMSEA = 0.124, $P(\text{rmsear} > 0.05)$ = 0.000; AIC = 7939.799. We therefore conducted an exploratory factor analysis (common factor analysis) on the eHEALS on half the sample (n = 199) with promax rotation. The analysis yielded a two-factor solution with 1.06% explained variance of prior communality estimates (e.g., estimates of the variance of the factor), all items revealing communalities of .49 and above, and

factor loadings higher than .48. The results of this analysis are displayed in Table 2. A reliability test on the two factors showed high internal consistency (Cronbach's α = 0.83 and α = 0.83) with a correlation of 0.67 between the two factors. The scale's descriptive statistics showed that it was normally distributed (Mean = 3.41; Median = 3.50; SD = .80; Skewness = -.29; Kurtosis = 0.33).

The dimensions uncovered in the above analysis on eHEALS were tested in a CFA using the second half of the sample and yielded good fit indices: χ^2 (19) = 33.158, p = 0.000; CFI = 0.974; RMSEA = 0.061, $P(\text{rmsea} > 0.05)$ = 0.000; AIC = 3910.724. Finally, the R^2 of individual items ranged from 0.406 to 0.506. Collapsing the model into one factor yielded poor fit: χ^2 (20) = 83.212, p = 0.000; CFI = 0.882; RMSEA = 0.126, $P(\text{rmsea} > 0.05)$ = 0.000; AIC = 3973.064.

In summary, the health literacy scale yielded 3 dimensions of seeking, understanding and appraising/applying; the eHealth literacy scale yielded 2 dimensions of seeking and appraising. The correlation between health literacy and eHealth literacy is moderate (r = .36, p < .05).

Discussion

Table 2
Standardized Factor loading and R^2 of eHEALS items in confirmatory factor analysis ($n=199$)

Item	Factor 1	Factor 2	R^2
I know how to find helpful health resources on the Internet	0.907		0.566
I know where to find helpful health resources on the Internet	0.901		0.812
I know how to use the Internet to answer my questions about health	0.753		0.822
I can tell high quality health resources from low quality ...		0.714	0.557
I feel confident in using information from the Internet to make health decisions		0.642	0.441
I know how to use the Internet to answer my questions about health		0.747	0.509
I have the skills I need to evaluate the health resources I find on the Internet		0.664	0.412
<u>I know what health resources are available on the Internet</u>		0.637	0.406

The study uncovered that both health literacy and eHealth literacy are multi-dimensional constructs rather than one dimensional and that they are moderately related.

The structure uncovered concurs with the literature, though it is not identical with previous findings. Though the theoretical underpinning of health literacy upholds four skills - seeking, understanding, evaluating and applying (Sorensen et al., 2012) – the latter two higher cognitive abilities (evaluating and applying) seem difficult to distinguish, at least in terms of the items, and they indeed hang together in the present analysis.

eHealth literacy was found to be made of 2 factors, similar to recent findings by Soellner, Huber, and Reder, (2015), albeit the two factors were found to harbor slightly different items.

The results of the study indicate that an overall index of health literacy and eHealth literacy should be computed as a mean of their underlying factors and not as a simple mean, as often practiced. The different dimensions should also be looked at separately in order to enrich our understanding of patients' difficulties and challenges in making sense of their health.

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