Int J Public Health (2017) 62:591–604
DOI 10.1007/s00038-017-0945-x

ORIGINAL ARTICLE

Structural properties and psychometric improvements of the Health Literacy Questionnaire in a Slovak population

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Received: 2 March 2016 / Revised: 10 January 2017 / Accepted: 10 January 2017 / Published online: 3 March 2017

Abstract

Objectives Health literacy is an important determinant of health and health equity and therefore requires robust measurement. The aim was to examine the psychometric properties of the Slovak version of the Health Literacy Questionnaire (HLQ) including revised wording of response categories.

Methods A cross-sectional survey of the general Slovak adult population ($N = 360$, mean age 39) was conducted with the HLQ following its translation and cultural adaptation. Psychometric tests (confirmatory factor analysis, Cronbach's alpha, composite reliability) and association (linear regression, ANOVA) with sociodemographic variables were undertaken. The performance of alternative version of response options were explored with the Mann–Whitney *U* test and item response theory.

Results A highly restrictive nine-factor confirmatory factor analysis showed acceptable fit [χ^2WLSMV = 1684 (df = 866), $p < 0.0001$; CFI = 0.943, TLI = 0.938, RMSEA = 0.051, WRMR = 1.297] and reliability was acceptable (range 0.73–0.84). The revised response categories had a better distribution with lower average scores in three domains, compared with the original, and improved item information curves.

Conclusions The nine HLQ scales are robust, providing a fine-grained assessment of health literacy. The revised response options improve psychometric properties and are recommended for future studies.

Keywords Health literacy · Measurement · Cultural adaptation · Item response theory · Psychometrics · Health Literacy Questionnaire (HLQ)

Introduction

Health literacy (HL) has received increasing attention over the last two decades and is gaining importance in health systems improvement, public health and health policy (Batterham et al. 2016; Sørensen et al. 2012). It has the potential to underpin a wide range of healthcare and health promotion programs and improve our capacity to tackle global health challenges, including the achievement of sustainable development goals and the reduction of disease burden due to non-communicable diseases (Dodson et al. 2015).

There are several definitions of HL but the most influential is the WHO definition which defines HL 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 (World Health Organization 1998). Definitions in general identify HL as the application of a group of skills (e.g. reading, writing, numeracy, etc.) which help to find, understand and process health information with the aim to gain orientation in healthcare systems and support the decision making and acting in ways that promote and maintain good health (Institute of Medicine 2004; World Health

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Organization 1998). At the 5th WHO Global Conference on health promotion, HL is not only distinguished as a range of skills and abilities but also understood as a key determinant of population health (Kanj and Mitic 2009).

Large scale surveys from Australia, USA (Barber et al. 2009; Australian Bureau of Statistics 2009; US Department of Health and Human Services 2008) and Europe, that assessed HL largely in relation to health-related reading ability, produced widely varying estimates of the prevalence of low HL (varying between 6.8 and 62%) (Sørensen et al. 2015). Also, it was concluded that most adults face the situation at some point in their lives where their HL is inadequate in relation to the complexity of the health issues that they face (Batterham et al. 2016). We argue that this high variation makes efforts to define thresholds of low HL are of dubious value, even more so since people may be categorized as having normal or high HL may still have problems with accessing, understanding and applying health information well enough to meet their needs. This paper examines a diagnostic/descriptive tool that identifies the HL strengths and limitations of individuals rather than trying to categorize people as having 'low' or 'high' HL.

The association of functional HL (i.e. HL assessed as health-related reading and numeracy ability) with health has been documented. Low HL is an independent risk factor for poorer health and increased mortality and also with the use of certain healthcare services, including increased hospitalizations and emergency care (Berkman et al. 2011; Kanj and Mitic 2009). Having lower HL negatively impacts disease prevention, screening activities (Davis et al. 2002; Miller et al. 2007) and poor adherence to medication (Pignone et al. 2005). People with lower health literacy tend to have more chronic conditions (Beauchamp et al. 2015; Hudon et al. 2012; Toci et al. 2015), lower education attainment and lower socio-economic position (Friis et al. 2016; Sørensen et al. 2015) and are less likely to live with partner or other people (Beauchamp et al. 2015).

Assessment of HL has advanced over the past two decades. Such tools vary in design and their approach to the concept of HL, as well as in their purpose (Sørensen et al. 2013). Systematic reviews have found that many have weak psychometric properties (Jordan et al. 2011) and most measure more than one dimension but principally assessed print literacy and numeracy and in some cases oral literacy (Altin et al. 2014). A lack of robust and standardized measurement tools severely limits the ability to compare HL initiatives (Pleasant and McKinney 2011). Haun et al. (2014) reviewed 51 HL tools and found that most measure a limited range of HL dimensions and the tools are limited by inadequate power to detect unbiased differences across groups (i.e. race, age, ethnicity and gender).

The HLQ was developed to overcome reported limitations of existing HL measurement tools (Jordan et al. 2011) and provide a comprehensive measure of HL capable of diagnosing HL needs across individuals and organisations (Osborne et al. 2013). The HLQ covers nine conceptually distinct areas of HL to assess the needs and challenges of a wide range of people and allows health-care providers, and policymakers to identify and understand the diversity of HL profiles in the populations that they serve (Batterham et al. 2014; Osborne et al. 2013).

In Europe, the European Commission (2015) has highlighted several weaknesses in the field of HL including the lack of well-validated measurement tools for the European context. The aim of our study was to generate robust evidence on the psychometric properties of the HLQ in a diverse sample of citizens in Slovakia—a European country with many health and social inequalities.

Methods

Procedure

A crosssectional study was conducted between December 2014 and February 2015. Respondents were recruited in dental offices during preventive check-ups. The proportion of the Slovak population attending preventive check-ups was 53.5% in 2013 according to National Health Information Center (National Health Information Center 2014). Demographic and socioeconomic characteristics (age, gender, education and employment status) of attendees reflect characteristics of the general population in Košice and Prešov region. Dental offices from urban and rural areas in Košice ($n=6$) and Prešov region ($n=2$) were asked to participate in the study, and 6 of them (Košice 4, Prešov 2) agreed to participate (2 were from rural areas). The questionnaires were distributed to all patients waiting for the preventive check-up in the waiting room. The participants were informed of the purpose and nature of the study and written consent was obtained. Completion of the self-administered questionnaire took from 15 to 25 min.

The study was approved by the Ethical Committee of the Faculty of Medicine P. J. Šafárik University (approval obtained on November 29, 2013).

Sample

A total of 360 participants (47.8% males) completed and returned the questionnaire giving a response rate of 72% out of 498 people invited to participate. The age of respondents ranged from 18 to 68 with mean age of 39 years (SD 14).

Measures

In addition to the HLQ, other variables collected inluded demographics (e.g. gender, age, cohabitation status) and socioeconomic status (employment status, educational attainment), chronic health conditions, and further health indicators not used in the present study (e.g. oral health, risky behaviours).

Cohabitation status data included with whom a respondent lived with (wife/husband, partner, alone or other) recategorized into: lives with somebody (1) or lives alone (2). Employment status was categorized as employed (1) (1 + 2), unemployed (2) (3 + 4), student (3) and retired (6 + 7). Educational attainment was grouped into: primary education (1), high school (2) and university (3). Finally, respondents could report upto ten chronic conditions (e.g. arthritis, diabetes, cancer) including "other" and "none". The total number of chronic conditions reported was categorised as no chronic disease (healthy) (1), one disease (2), two diseases (3), three diseases (4) and four diseases (5). Nobody reported more than 4 chronic diseases.

The Slovak version of HLQ was created through a translation procedure developed by the HLQ authors. Using an extensive item intent document, the HLQ was translated into Slovak independently by a professional translator and interpreter, and by a translator with extensive background in local clinical and community contexts setting. Differences in two forward translations were discussed and a recommended draft Slovak version was prepared and backtranslated separately by two bilinguals with English as a primary language. Differences in the backtranslated versions were discussed and a final version was sent to an HLQ author (RHO) for review. Nuances in Slovak translation and the original English intent of each item were then discussed in detail in three 4 h conferences between authors, translators, biliguals and researcher team members to generate the final recommended Slovak version.

The Health Literacy Questionnaire (HLQ) (Osborne et al. 2013) comprises nine domains to provide a detailed profile of HL of populations, groups or patients of interest (see Table 1).

The original HLQ is divided into two parts which differ in response categories. Part 1 (domains 1–5) has 4 response catogories rating the extent of agreement (see Table 1). Part 2 (domains 6–9) has 5 response categories rating the level of difficulty: cannot do (1), very difficult (2), quite difficult (3), quite easy (4) and very easy (5). The HLQ authors subsequently proposed an improved scale which was regarded as a better way to rate daily experiences with the tasks identified in the items. The revised scale was: cannot do or always difficult (1), usually difficult (2), sometimes difficult (3), usually easy (4) and always easy (5). We used the original (version A) and the revised (version B) of the Part 2 of HLQ to empirically determine each scales' measurement properties. Each domain was scored as the average of the item scores.

Data analysis

Descriptive statistics [e.g. frequency, mean, standard deviation (SD)] followed by reliability (Cronbach's alpha and composite reliability) were calculated for each scale and differential item functioning (DIF) with contrasts: gender, age, education and chronic condition were analysed using linear regression for each item of HLQ-SK according to Zumbo (1999). Factor structure was tested using confirmatory factor analysis (CFA). As a further step, we analysed differences in the score between demographic and socioeconomic categories using a linear regression and ANOVA. A final step was the comparison of the four scales in the

Table 1 Health Literacy Questionnaire domains with indication of the number of items and range of response categories (Slovakia 2014–2015)

HLQ domains	Number of items	Response categories
1. Feeling understood and supported by healthcare providers	4	Strongly disagree—1/disagree—2/agree—3/strongly agree—4
2. Having sufficient information to manage my health	4	Strongly disagree—1/disagree—2/agree—3/strongly agree—4
3. Actively managing my health	4	Strongly disagree—1/disagree—2/agree—3/strongly agree—4
4. Social support for health	5	Strongly disagree—1/disagree—2/agree—3/strongly agree—4
5. Appraisal of health information	5	Strongly disagree—1/disagree—2/agree—3/strongly agree—4
6. Ability to actively engage with healthcare providers	5	Version A[a] or Version B[b] (1–5)
7. Navigating the healthcare system	6	Version A[a] or Version B[b] (1–5)
8. Ability to find good health information	5	Version A[a] or Version B[b] (1–5)
9. Understanding health information well enough to know what to do	5	Version A[a] or Version B[b] (1–5)

[a] Version A response categories: cannot do (1), very difficult (2), quite difficult (3), quite easy (4) and very easy (5)

[b] Version B response categories: cannot do or always difficult (1), usually difficult (2), sometimes difficult (3), usually easy and (4), always easy (5)

Part 2 to explore the version A and B response options using Mann–Whitney *U* test. We also performed item response theory (IRT) analysis that fits a polytomous IRT model to ordinal data using Samejima's graded response model. Statistical analyses were performed using IBM SPSS 22.0 and MPlus 6.12.

Results

Descriptive statistics of the sample showed that the sample comprised slightly more women than men, the most frequently populated demographic subgroups were 18–30 years age, high school education, being employed, and living with someone in the household (Table 2). The most frequently reported chronic disease was back pain (31.2%) followed by cardiovascular disease (10.3%), but about half of the respondents did not report any chronic condition. More women than men reported at least one chronic condition. Women reported somewhat more back pain and depression or anxiety compared to men.

Psychometric properties

Internal consistency of each scale, as shown by Cronbach's alphas and composite reliability coefficients ranged from 0.73 to 0.84, the lowest reliability estimate was for "5—appraisal of health information" scale and highest for "6—ability to actively engage with healthcare providers". Scales did not show substantial floor or ceiling effects. Among Parts 1 and 2 scales we did not find any definitively disordered items using Item response theory analyses (Andrich 2013). DIF analyses showed items' independence from subgroup membership regarding gender, age category and education category and rather small differences in seven items related to respondent's chronic condition.

Average scores for the scales ranged from 2.70 to 2.94 in the first five domains (with response categories 1–4) and from 3.31 to 3.58 in domains six to nine (with response categories 1–5). Psychometric results are shown in Tables 3 and 4. C onfirmatory factor analysis (CFA) explored the internal structure of Slovak HLQ according to predefined original HLQ structure. The resulting fit indices of a highly restricted nine-factor model with no item residual correlations and no cross loading of items across scales showed satisfactory goodness of fit [$\chi^2_{\mathrm{WLSMV}} = 1684.96$ ($df = 866$), $p < 0.001$; CFI = 0.943, TLI = 0.938, RMSEA = 0.051, and WRMR = 1.297].

Comparison of response categories in Part 2

Comparison of the average scores of the domains in Part 2 with two different response categories wording (versions A and B) showed that wording used in version B yielded lower average scores and the differences were statistically significant in three of the four domains (7–9). Internal consistency, expressed by Cronbach's alpha, was similar in A and B version. Item response theory analyses showed that version B had substantially better response category thresholds than version A. Version B response categories resulted in better ordered and better balanced categories (see Fig. 1 for examples). Scales with version B response categories showed smaller ceiling effect, except scale 7, and similarly low flooring effect as version A categories.

Demographic and socioeconomic differences between subgroups

We did not find many differences within socio-demographic subgroups in most of the HLQ domains using linear regression and ANOVA (Table 5). We found, however, significantly higher scores for women in domains 1, 5 and 9, higher scores among those who live with somebody in domains 4 and 5. Unemployed respondents had lower scores compared to those employed in the domain 4, and respondents with one chronic diseases had higher score in domain 8 than respondents with 3 chronic diseases. Lower education was significantly related to lower HL across all domains. Specifically, university educated respondents tended to have higher scores compared with people with only primary education (domains 1, 3, 6, 7) and people with at least secondary education (domains 1, 2, 4, 5, 8, 9).

Discussion

The Slovak version of the HLQ has strong psychometric properties which was evidenced by full reproduction of the original English language nine-factor structure using a highly restrictive confirmatory factor analytic approach, in a different language among people from a different culture and engaging in a different healthcare system. While the original response options worked well, modifications to them resulted in improved measurement properties.

The psychometric reproduction of the HLQ in our Central European setting suggests that the concept of HL that the questionnaire is robust and serves as a good foundation for valid measurement across countries. While the tool is being used in many other countries with empirical and psychometric studies in process, this is the first to explore its psychometric properties in Central Europe. While initial data indicate robust psychometric properties in several different European languages, e.g. German, Danish, Dutch and Czech (Maindal et al. 2016; Osborne, personal communication), only two studies have reported any psychometric properties to date. Bo et al. (2014) applied two

Table 2 Sociodemographic characteristics (numbers and percentages) and frequency of chronic conditions in Slovak adults ($N = 360$) (Slovakia 2014–2015)

	Men			Women			Total		
	n	Mean (SD), range or %	Missing (*n*)	*n*	Mean (SD) or %	Missing (*n*)	*n*	Mean (SD), range or %	Missing
Age (continuous)	171	38.7 (13.8), (18–67)	1	186	38.6 (14.2), (18–68)	2	357	38.6 (13.95), (18–68)	3
Age categories (years)			1			3			4
18–30	68	39.8		73	39.5		141	39.6	
31–44	40	23.4		48	25.9		88	24.4	
45–64	55	32.,2		59	31.9		114	32.0	
>65	8	4.7		5	2.7		13	3.7	
Cohabitation status			6			5			11
Living with somebody	126	75.9		151	82.5		277	79.4	
Living alone	40	24.1		32	17.5		72	20.6	
Employment status									
Employed	123	71.5		115	61.2		238	66.1	
Unemployed	13	7.6		19	10.1		32	8.9	
Student	17	9.9		27	14.4		44	12.2	
Retired	20	11.6		23	12.3	1	43	12	1
Educational attainment									
Primary school	5	2.9		8	4.3		13	3.6	
High school	130	75.6		114	60.6		244	67.8	
University	37	21.5		66	35.1		103	28.6	
Number of chronic diseases*			1						1
Without diseases	101	59.1		88	46.8		189	52.6	
One diseases	51	29.8		66	35.1		117	32.6	
Two diseases	13	7.6		25	13.3		38	10.6	
Three diseases	6	3.5		5	2.7		11	3.1	
Four diseases	0	0		4	2.1		4	1.1	
Type of chronic disease									
Back pain	45	26.3	1	67	35.6		112	31.2	1
Cardiovascular disease	19	11.1	1	18	9.6		37	10.3	1
Diabetes mellitus	9	5.3	1	7	3.7		16	4.5	1
Asthma	7	4.1	1	12	6.4		19	5.3	1
Other disease	7	4.1	1	19	10.1		26	7.2	1
Depression, anxiety	1	0.6	1	17	9		18	5.0	1
Cerebrovascular disease	4	2.3	1	1	0.5		5	1.4	1
Arthritis	3	1.8	1	4	2.1		7	1.9	1

HLQ scales ("6—ability to actively engage with healthcare professionals", and "9—understand health information well enough to know what to do") in the Danish National Health Survey ($n = 29{,}000$) and found that they had good reliability and returned rich epidemiological information about the Danish population (Friis et al. 2016). Maindal et al. (2016) recently reported strong construct and content validity, and high composite reliability of whole nine scale Danish version of HLQ.

Given the strong properties of the HLQ-SK, this HL tool is likely to provide stakeholders with reliable data on whole populations and in subgroups. The nine domains were

Table 3 Descriptive statistics for scale scores and internal consistency coefficients of the Slovak Health Literacy Questionnaire domains (Slovakia 2014–2015)

	1. Feeling understood and supported by healthcare providers	2. Have sufficient information to manage health	3. Actively managing my health	4. Social support for health	5. Appraisal of health information	6. Ability to actively engage with healthcare providers	7. Navigating the healthcare system	8. Ability to find good health information	9. Understanding health information well enough to know what to do
Mean score (SD)	2.87 (0.51)	2.70 (0.55)	2.77 (0.52)	2.94 (0.50)	2.70 (0.52)	3.43 (0.69)	3.31 (0.70)	3.55 (0.73)	3.58 (0.67)
Min score	1.25	1.25	1	1	1.2	1.4	1.5	1	1.4
Max score	4	4	4	4	4	5	5	5	5
Number of items	4	4	5	5	5	5	6	5	5
Floor[a]	2.0%	2.5%	1.1%	0.6%	1.4%	See Table 4	See Table 4	See Table 4	See Table 4
Ceiling[b]	12.6%	9.8%	7.6%	11.8%	7.8%	See Table 4	See Table 4	See Table 4	See Table 4
N	356	356	356	357	357	354	356	355	356
Cronbach's alpha	0.75	0.74	0.76	0.77	0.73	0.84	0.83	0.83	0.76
Composite reliability (95% CI)	0.75 (0.71–0.79)	0.74 (0.70–0.79)	0.76 (0.72–0.80)	0.77 (0.72–0.81)	0.73 (0.69–0.78)	0.84 (0.81–0.86)	0.83 (0.81–0.86)	0.83 (0.80–0.85)	0.76 (0.73–0.77)

[a] Proportion of respondents with average scale score 1.5 or less

[b] Proportion of respondents with average score 3.5 or higher

Table 4 Comparison of the mean values for the Health Literacy Questionnaire scales 6 to 9 (Part 2) between difficulty (A) and modified frequency-difficulty (B) versions (Slovakia 2014–2015)

Versions	6. Ability to actively engage with healthcare providers		7. Navigating the healthcare system		8. Ability to find good health information		9. Understanding health information well enough to know what to do	
	A	B	A	B	A	B	A	B
Mean score (SD)	3.49 (0.71)	3.39 (0.68)	3.41 (0.70)	3.22 (0.69)	3.68 (0.74)	3.44 (0.70)	3.71 (0.69)	3.47 (0.65)
Floor[a]	3.2%	2.0%	5.0%	2.6%	3.1%	3.1%	1.3%	1.0%
Ceiling[b]	7.0%	5.1%	4.4%	5.1%	10.0%	6.7%	14.4%	6.1%
Cronbach's alpha	0.84	0.84	0.82	0.85	0.83	0.81	0.76	0.75
N	157	197	160	196	160	195	160	196
Mean rank	181.71	170.16	196.13	164.11	199.47	160.38	199.46	161.39
U test value	14,018.5		12,859.5		12,164.5		12,326.5	
p value	0.13		0.003		0.000		0.000	

[a] Proportion of respondents with average scale score 2 or less

[b] Proportion of respondents with average score 4.5 or higher

found to be distinct, thus the HLQ-SK will be able to create HL profiles of populations which will clearly indicate the HL strengths and limitations of individuals across settings. Reliable and psychometrically sound data, that indicate the diversity of HL strengths and limitations in a population or group, will support the design of intervention programs that respond to these diverse needs. The HLQ is already used as tool for needs assessment for focusing intervention strategies in an intervention development process called the Ophelia (OPtimising HEalth LIteracy and Access) approach (Batterham et al. 2014). Ophelia aims to improve health and reduce health inequalities by increasing the availability and accessibility of health information and services in locally appropriate ways.

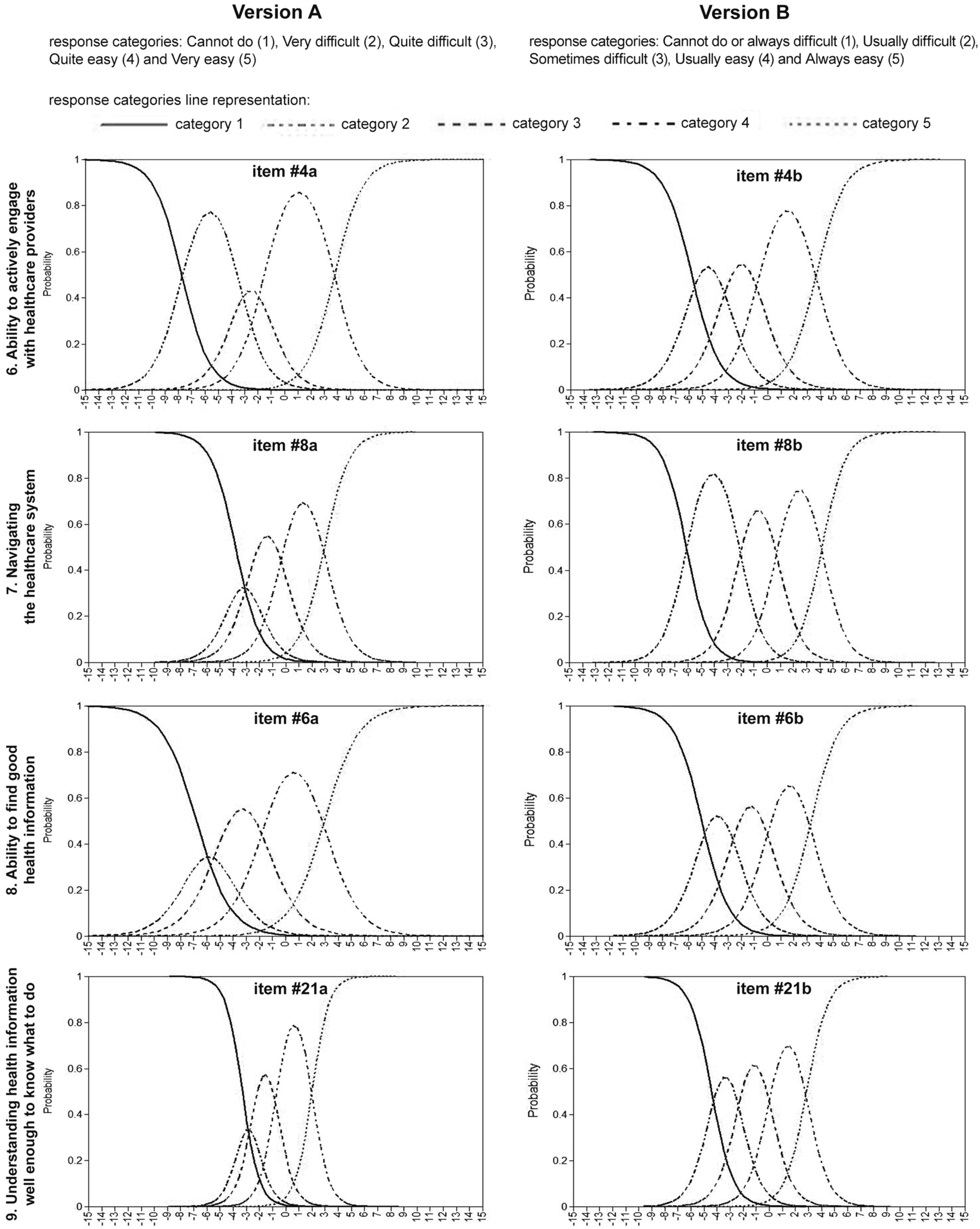

Fig. 1 Comparison of selected items from Part 2 scales with versions A and B response categories using item characteristic curves from item response theory analysis (Slovakia 2014–2015). Item characteristic curves demonstrate the performance of each item in a scale. If items have overlap, which is most strongly seen in category 3 (item #4a) and category 2 (items #8a, 6a, 21a) it means respondents cannot distinguish effectively between adjacent response options. Well-separated curves indicate sufficient differentiation of response categories as shown for all curves using the revised scales (version B)

Table 5 Mean scores for Health Literacy Questionnaire domains across socio-demographic subgroups, linear regression coefficients (B) with 95% confidence intervals and ANOVA test (*F* and *p* value) for differences among subgroups with more than two categories (Slovakia 2014–2015)

	1. Feeling understood and supported by healthcare providers	2. Have sufficient information to manage health	3. Actively managing my health	4. Social support for health	5. Appraisal of health information	6. Ability to actively engage with healthcare providers	2. Navigating the healthcare system	8. Ability to find good health information	9. Understand health information well enough to know what to do
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Sex									
Men (Ref. category)	2.81 (0.54)	2.66 (0.58)	2.76 (0.52)	2.93 (0.49)	2.64 (0.51)	3.40 (0.72)	3.29 (0.73)	3.47 (0.78)	3.49 (0.70)
Women	2.93 (0.49)	2.73 (0.53)	2.77 (0.52)	2.96 (0.51)	2.76 (0.53)	3.47 (0.67)	3.33 (0.67)	3.61 (0.68)	3.66 (0.64)
B (95% CI): women vs. men	0.11 (0.01|0.22)*	0.07 (−0.04|0.19)	0.01 (−0.10|0.12)	0.04 (−0.07|0.14)	0.12 (0.01|0.23)*	0.07 (−0.08|0.22)	0.04 (−0.10|0.19)	0.14 (−0.01|0.29)	0.18 (0.04|0.32)**
Age group									
18–30 years (Ref. category)	2.84 (0.51)	2.76 (0.58)	2.79 (0.55)	2.95 (0.51)	2.71 (0.53)	3.49 (0.67)	3.33 (0.69)	3.63 (0.69)	3.59 (0.67)
31–44 years	2.88 (0.51)	2.70 (0.53)	2.69 (0.47)	2.91 (0.52)	2.71 (0.54)	3.35 (0.61)	3.20 (0.66)	3.45 (0.70)	3.44 (0.62)
45–64 years	2.90 (0.47)	2.60 (0.52)	2.78 (0.50)	2.94 (0.45)	2.70 (0.47)	3.40 (0.76)	3.33 (0.72)	3.52 (0.76)	3.67 (0.67)
>65 years	2.81 (0.82)	2.73 (0.69)	2.83 (0.70)	3.06 (0.70)	2.55 (0.70)	3.63 (0.96)	3.49 (0.92)	3.43 (0.99)	3.54 (1.00)
ANOVA: *F* (*p* value)	0.31 (0.82)	1.50 (0.22)	0.81 (0.49)	0.40 (0.75)	0.37 (0.77)	1.12 (0.34)	1.04 (0.37)	1.28 (0.28)	2.03 (0.11)
B (95% CI): 31–44 years vs. Ref.	0.04 (−0.10|0.18)	−0.06 (−0.21|0.09)	−0.10 (−0.24|0.04)	−0.04 (−0.18|0.09)	0.00 (−0.14|0.14)	−0.14 (−0.32|0.05)	−0.13 (−0.32|0.06)	−0.18 (−0.37|0.02)	−0.15 (−0.33|0.03)
B (95% CI): 45–64 years vs. Ref.	0.05 (−0.07|0.18)	−0.15 (−0.28|− 0.01)*	−0.01 (−0.14|0.12)	−0.02 (−0.14|0.11)	−0.01 (−0.15|0.12)	−0.08 (−0.26|0.09)	0.00 (−0.18|0.17)	−0.12 (−0.30|0.07)	0.08 (−0.08|0.25)
B (95% CI): >65 years vs. Ref.	−0.04 (−0.33|0.26)	−0.03 (−0.34|0.29)	0.04 (−0.26|0.34)	0.11 (−0.18|0.39)	−0.16 (−0.46|0.14)	0.15 (−0.25|0.54)	0.16 (−0.24|0.55)	−0.20 (−0.62|0.21)	−0.05 (−0.43|0.33)

Table 5 (continued)

	1. Feeling understood and supported by healthcare providers Mean (SD)	2. Have sufficient information to manage health Mean (SD)	3. Actively managing my health Mean (SD)	4. Social support for health Mean (SD)	5. Appraisal of health information Mean (SD)	6. Ability to actively engage with healthcare providers Mean (SD)	2. Navigating the healthcare system Mean (SD)	8. Ability to find good health information Mean (SD)	9. Understand health information well enough to know what to do Mean (SD)
Cohabitation									
Living with others (Ref. category)	2.89 (0.52)	2.69 (0.56)	2.80 (0.52)	2.98 (0.50)	2.72 (0.54)	3.43 (0.72)	3.30 (0.72)	3.55 (0.75)	3.60 (0.67)
Living alone	2.78 (0.48)	2.68 (0.53)	2.64 (0.51)	2.81 (0.47)	2.64 (0.47)	3.43 (0.63)	3.30 (0.63)	3.51 (0.67)	3.46 (0.71)
B (95% CI): living with others vs. Ref.	−0.12 (−0.25|0.02)	−0.01 (−0.15|0.14)	−0.16 (−0.29|−0.02)*	−0.16 (−0.29|−0.03)*	−0.08 (−0.21|0.06)	0.00 (−0.18|0.19)	0.01 (−0.18|0.19)	−0.03 (−0.22|0.16)	−0.15 (−0.33|0.03)
Employment status									
Employed (Ref. category)	2.88 (0.54)	2.68 (0.57)	2.74 (0.49)	2.94 (0.50)	2.72 (0.52)	3.41 (0.69)	3.28 (0.70)	3.53 (0.73)	3.56 (0.69)
Unemployed	2.78 (0.49)	2.57 (0.52)	2.75 (0.59)	2.75 (0.53)	2.60 (0.51)	3.30 (0.63)	3.26 (0.66)	3.41 (0.61)	3.37 (0.68)
Student	2.88 (0.45)	2.75 (0.54)	2.73 (0.60)	2.95 (0.49)	2.65 (0.53)	3.53 (0.58)	3.33 (0.63)	3.68 (0.58)	3.72 (0.49)
Retired	2.88 (0.44)	2.74 (0.50)	2.84 (0.53)	3.03 (0.44)	2.69 (0.54)	3.50 (0.85)	3.38 (0.74)	3.49 (0.92)	3.61 (0.76)
ANOVA: *F* (*p* value)	0.81 (0.52)	0.84 (0.50)	1.48 (0.21)	3.04 (0.02)*	1.28 (0.28)	0.99 (0.41)	0.95 (0.44)	1.28 (0.28)	1.45 (0.22)
B (95% CI): unemployed vs. Ref.	−0.12 (−0.31|0.08)	−0.12 (−0.33|0.09)	−0.01 (−0.21|0.19)	−0.20 (−0.39|−0.02)*	−0.13 (−0.33|0.07)	−0.11 (−0.38|0.16)	−0.03 (−0.30|0.24)	−0.13 (−0.41|0.14)	−0.20 (−0.46|0.06)
B (95% CI): student vs. Ref.	−0.01 (−0.17|0.16)	0.06 (−0.12|0.24)	−0.02 (−0.19|0.14)	0.00 (−0.16|0.16)	−0.08 (−0.25|0.09)	0.11 (−0.11|0.34)	0.03 (−0.19|0.26)	0.13 (−0.11|0.37)	0.15 (−0.07|0.36)

Table 5 (continued)

	1. Feeling understood and supported by healthcare providers Mean (SD)	2. Have sufficient information to manage health Mean (SD)	3. Actively managing my health Mean (SD)	4. Social support for health Mean (SD)	5. Appraisal of health information Mean (SD)	6. Ability to actively engage with healthcare providers Mean (SD)	2. Navigating the healthcare system Mean (SD)	8. Ability to find good health information Mean (SD)	9. Understand health information well enough to know what to do Mean (SD)
B (95% CI): retired vs. Ref.	0.0 (−0.17|0.17)	0.05 (−0.13|0.24)	0.09 (−0.09|0.26)	0.08 (−0.08|0.25)	−0.04 (−0.21|0.14)	0.09 (−0.14|0.32)	0.08 (−0.15|0.31)	(−0.06 (0.30|0.18)	0.04 (−0.18|0.26)
Chronic diseases									
Without diseases (Ref. category)	2.86 (0.50)	2.73 (0.57)	2.77 (0.52)	2.94 (0.49)	2.66 (0.53)	3.52 (0.69)	3.38 (0.69)	3.65 (0.70)	3.62 (0.68)
One disease	2.89 (0.56)	2.70 (0.53)	2.73 (0.53)	2.94 (0.54)	2.74 (0.54)	3.35 (0.69)	3.23 (0.72)	3.42 (0.76)	3.54 (0.67)
Two diseases	2.92 (0.43)	2.56 (0.50)	2.79 (0.54)	2.98 (0.48)	2.75 (0.52)	3.29 (0.67)	3.28 (0.68)	3.51 (0.69)	3.52 (0.72)
Three diseases	2.89 (0.68)	2.43 (0.74)	2.91 (0.37)	2.96 (0.41)	2.89 (0.29)	3.18 (0.58)	2.95 (0.71)	3.18 (0.76)	3.47 (0.57)
Four diseases	3.00 (0.00)	2.75 (0.35)	2.90 (0.26)	2.95 (0.10)	2.75 (0.34)	3.65 (1.11)	3.33 (0.49)	3.55 (0.82)	3.65 (0.72)
ANOVA: *F* (*p* value)	0.20 (0.94)	1.45 (0.22)	0.41 (0.80)	0.07 (0.99)	0.90 (0.46)	2.04 (0.09)	1.62 (0.17)	2.72 (0.03)	0.44 (0.78)
B (95% CI): one disease vs. Ref.	0.03 (−0.09|0.15)	−0.04 (−0.17|0.09)	−0.03 (−0.16|0.09)	0.01 (−0.11|0.12)	0.08 (−0.04|0.20)	−0.17 (−0.34|−0.01)	−0.15 (−0.31|0.01)	−0.24 (−0.41|−0.07)**	−0.08 (−0.24|0.08)
B (95% CI): two diseases vs. Ref.	0.06 (−0.12|0.24)	−0.18 (−0.38|0.02)	0.03 (−0.16|0.21)	0.05 (−0.13|0.22)	0.09 (−0.10|0.28)	−0.23 (−0.47|0.02)	−0.11 (−0.35|0.14)	−0.15 (−0.40|0.11)	−0.11 (−0.34|0.13)
B (95% CI): three diseases vs. Ref.	0.03 (−0.28|0.34)	−0.30 (−0.64|0.34)	0.14 (−0.18|0.46)	0.03 (−0.28|0.33)	0.23 (−0.09|0.55)	−0.34 (−0.76|0.08)	−0.43 (−0.85|0.00)	−0.47 (−0.91|−0.03)*	−0.15 (−0.56|0.27)

Table 5 (continued)

	1. Feeling understood and supported by healthcare providers	2. Have sufficient information to manage health	3. Actively managing my health	4. Social support for health	5. Appraisal of health information	6. Ability to actively engage with healthcare providers	2. Navigating the healthcare system	8. Ability to find good health information	9. Understand health information well enough to know what to do
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
B (95% CI): four disease vs. Ref.	0.14 (−0.37|0.65)	0.02 (−0.53|0.56)	0.13 (−0.39|0.65)	0.01 (−0.49|0.51)	0.09 (−0.43|0.61)	0.13 (−0.56|0.82)	−0.05 (−0.74|0.65)	−0.10 (−0.82|0.61)	0.03 (−0.64|0.70)
Education attainment									
Elementary education	2.65 (0.55)	2.54 (0.56)	2.26 (0.61)	2.42 (0.66)	2.63 (0.56)	3.05 (0.68)	2.94 (0.82)	3.48 (0.73)	3.43 (0.66)
Secondary education	2.85 (0.52)	2.64 (0.55)	2.77 (0.49)	2.94 (0.48)	2.67 (0.51)	3.42 (0.70)	3.28 (0.70)	3.48 (0.74)	3.53 (0.67)
University (Ref. category)	2.97 (0.48)	2.85 (0.52)	2.82 (0.54)	3.03 (0.48)	2.80 (0.53)	3.51 (0.68)	3.41 (0.65)	3.72 (0.69)	3.71 (0.66)
ANOVA: *F* (*p* value)	3.27 (0.04)*	5.80 (0,00)**	7.02 (0.00)***	9.18 (0.00)***	2.41 (0.09)	2.76 (0.06)	3.19 (0.04)*	3.89 (0.02)*	2.93 (0.05)*
B (95% CI): elementary education vs. Ref.	−0.31 (−0.61|−0.02)*	−0.31 (−0.64|0.02)	−0.56 (−0.86|−0.27)***	−0.61 (−0.90|−0.33)	−0.17 (−0.47|0.13)	−0.47 (−0.87|−0.07)*	−0.48 (−0.88|−0.08)*	−0.24 (−0.66|0.18)	−0.28 (−0.67|0.11)
B (95% CI): secondary education vs. Ref.	−0.12 (−0.24|0.00)*	−0.21 (−0.34|−0.08)***	−0.06 (−0.18|0.06)	−0.09 (−0.21|0.33)***	−0.13 (−0.25|0.01)*	−0.09 (−0.25 |0.07)	−0.13 (−0.29|0.03)	−0.24 (−0.41|−0.07)**	−0.18 (−0.34|−0.03)*

$^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

We found that HL measured with HLQ-SK did not differ substantially in most domains between respondent subgroups including: gender, age, cohabitation status and employment status. However, women tended to score higher in three scales (1, 5 and 9) covering feeling understood, appraisal of health information, and understanding health information, but no specific pattern was evident in other HLQ-SK scales. Our findings on the absence of the differences in most of the scales between most of the assessed subgroups are similar to some earlier HL studies (Beauchamp et al. 2015; Bo et al. 2014; Maindal et al. 2016). The finding that women perceive fewer difficulties with health information than men, especially in the domains of healthcare and disease prevention, corresponds with the study of van der Heide et al. (2013a) conducted in a Dutch population. Furthermore, women's higher scores on feeling understood and supported by health-care providers, higher appraisal skills and higher understanding of health information may reflect gender differences in social skills and also the role of women in our society where women usually take care of family members' health and also health related information in media is often targeted to women in caring roles.

As expected, cohabitating respondents had higher scores in the 4. Social support for health scale compared with people living alone. They also reported higher 3. Actively managing health, i.e. the cohabitant may provide some motivation and support to be healthy. People who were employed tended to report higher 4. Social support for health, compared with unemployed people.

Similarly, findings of lower HL scores among people living alone and people with low socioeconomic position (with low income, low education level, being born in another country, without private health insurance, English not spoken at home) were reported in Beauchamp et al. (2015) and Bo et al. (2014).

In the European Health Literacy Survey, older groups tended to have lower HL (HLS-EU Consortium 2012). In a Dutch population a negative association was found between age and accessing information on healthcare and disease prevention and understanding information on disease prevention and health promotion (van der Heide et al. 2013b).

On the other hand, subgroups based on educational attainment differed in the level of HL in all domains. Respondents with tertiary education had higher HL levels compared to respondents with only secondary or elementary education. This finding is consistent with prior studies (Bo et al. 2014; van der Heide et al. 2013b). Our study, however, shows that people with university education had highest level of HL across all HLQ domains even in the domains that do not have a direct or obvious connection with formal education, such as scales that relate to social skills. In terms of the impact of HL strengths and limitations, Van der Heide et al. (2013b) in their mediation analysis found that HL plays a larger role among those with lower education than among those with higher education.

The number of chronic health conditions in respondents was associated only with scale 8. Ability to find good health information. Respondents with one chronic condition had higher ability compared to respondents with three chronic conditions. This is in line with the Dutch study where lower levels of HL we found among patient with multimorbidity (Heijmans et al. 2015). In other domains we did not identify any recognizable trend related with increasing number of health conditions. Research by Edwards et al. (2012) suggests that HL skills can develop over time, where skills are put into practice and patients become more active in healthcare consultations as their confidence and experience increases. An important element of the HLQ scales and items is that they were specifically formulated such that men and women, adults of any age, and people with and without disease, would understand the questions in the same way, to provide unbiased estimates of mean differences between populations. The unbiased item functioning was supported by DIF analysis in Slovak language setting. This is important to ensure that any differences seen between subpopulations reflects 'true' differences in HL, rather than bias related to different interpretations of items/concepts of one group compared with another.

The HLQ was developed using a grounded approach, consequently the HLQ includes dimensions not covered in other HL tools. The most common element in HL tools to date has been reading and numeracy skills related to health, i.e. HLQ's scale "9—understanding health information well enough to know what to do", which is also described as functional HL. Previous studies have found low functional HL and limited English proficiency were related to health status and also varied by racial/ethnic group. It is interesting to note that large proportions of some racial/ethnic subgroups with limited English did not report challenges with health information (Sentell and Braun 2012), which may be explained by other HL skills such as scale "4. Social support for health", or scale "1. Feeling understood and supported by healthcare professionals". Functional HL partially explained differences in health status and, to a lesser degree, receipt of vaccinations that would normally be attributed to educational attainment or race if literacy was not considered (Howard et al. 2006).

Comparison of the different wording in response categories A and B in Part 2 of the HLQ demonstrated that scores using the B options were lower in almost all scales compared with A. The purpose of the rewording was to allow respondents options that are more in line with real world behaviour. In the original wording (A) the extreme values cannot do and very difficult, were too absolute (extreme), and didn't allow for tasks being difficult some of the time, which is a more natural phenomenon. Overall, it suggests that the response option “cannot do/very difficult” is not fully complimentary with the nature of the items in Version A; for some reason respondents are typically moving from “cannot do/very difficult” to “quite difficult” when choosing a response and less frequently choosing “cannot do/very difficult”. This shift from the lowest category caused an increase in the average scores and thus might slightly skew and overestimated the respondent’s HL level. Conversely, the inclusion of the element of frequency in the response option allowed more people to mark lower scores thus reducing ceiling effects and improving the distribution of responses. It is now expected that the revised version will be more sensitive to changes across groups and over time.

Strengths and limitations

A limitation of our study is sample size, particularly the relatively small number of people above 65 years of age, which may limit the generalizability of the results to the whole Slovak adult population. Our sample represents relevant subgroups regarding gender, age, education attainment and economic status, however with a shifts towards overrepresentation of the people with secondary education and university degrees compared with people with elementary education or less. However, the region selected is less urbanized and less industrialized than in other regions in Slovakia, with relatively higher unemployment rate than state average (Statistical Office of the Slovak Republic 2015).

A second limitation is that we were not able to collect any longitudinal data and therefore cannot provide any information on sensitivity to change over time. This should be a priority for future research. Third, as the questionnaire was administered in waiting rooms before or after the dentist visit the sample may be biased towards people who are participating in at least one preventive healthcare activity (dental check-ups) and may, therefore, not include people who are disconnected from health services. Notwithstanding this, the psychometrics of the tool and the low amount of missing data suggest that the nature and structure of the questions are robust even in a busy clinical setting. Future research into the HLQs performance should include tests of convergent validity where functional HL tests and indicators of service quality and ease of access are also administered.

It should be noted that our study had a high response rate (72%). While it is likely that people who refused to take part were unable to read, or find answering questionnaires by themselves intimidating, the data demonstrate a good spread of responses (from low to high HL), and many respondents were from a low socioeconomic position.

Conclusion

Our study provides psychometric assessment of Slovak version of the HLQ. The data indicate that its comprehensive set of HL scales is reliable and psychometrically robust, even when subjected to highly restrictive confirmatory factor analyses. We compared two types of wording for response options and demonstrated that the revised wording improves the distribution of scores. The HLQ-SK allows multi-dimensional and comprehensive HL assessment that has previously not been available in research or public health setting.

Acknowledgements This work was partially funded by the Research and Development Support Agency (APVV-0032-11). Richard Osborne was funded in part through a National Health and Medical Research Council of Australia Senior Research Fellowship #APP1059122.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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