Original Article

Structural Analysis of the Health Literacy Facet Access to Information on General Health, COVID-19 Infection Prevention, and Early Childhood Allergy Prevention in Pregnant Women and Mothers of Infants

Psychometric Characteristics of the Access Items in the European Health Literacy Survey (HLS-EU-Q47)

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Abstract: The health literacy (HL) facet Access to health information is measured in the European Health Literacy Survey (HLS-EU-Q47) by 12 items. To assess Access, we developed adapted item formulations for COVID-19 infection prevention (COVID-19-IP) and early childhood allergy prevention (ECAP) in addition to the original 12 items on General Health (GH). N = 343 (expectant) mothers of infants answered the items in an online assessment. Confirmatory structural analyses for ordinal data were adopted (WLSMV-algorithm). Women's item ratings varied significantly across domains (η^2 = .017 – .552). Bi-factor models exhibited the best data fit (GH / COVID-19-IP / ECAP: CFI = .964 / .968 / .977; SRMR: .062 / .069 / .035): The general factor Access most strongly determined item information. Additionally, three subfactors contributed significantly (but rather weakly) to the item information in each domain. The overall score Access proved to be internally consistent (McDonald's $\omega_{GH/COVID\text{-}19\text{-}IP/ECAP}$ = .874 / .883 / .897) and was associated with socioeconomic state (McArthur scale; $r_{GH/COVID\text{-}19\text{-}IP/ECAP}$ = .218 / .210 / .146). Access correlated not or only weakly with the other HL facets Understand, Appraise, and Apply. The health domains GH, COVID-19-IP, and ECAP moderated both the difficulty and the dimensional structure of the 12 Access items. This suggests that in the HLS-EU Access reflects not only the search competence but also the availability of health information.

Keywords: access to health information, European Health Literacy Survey (HLS-EU-Q47), health literacy, COVID-19, early childhood allergy prevention

Strukturanalyse der Gesundheitskompetenzfacette „Zugang zu Informationen" zu allgemeiner Gesundheit, COVID-19-Infektionsprävention und frühkindliche Allergieprävention bei schwangeren Frauen und Müttern von Kleinkindern: Psychometrische Eigenschaften der Items zum „Zugang zu Information" im European Health Literacy Survey (HLS-EU-Q47)

Zusammenfassung: Die Gesundheitskompetenz- (GK) Facette Zugang zu Gesundheitsinformationen wird durch 12 Items im European Health Literacy Survey (HLS-EU-Q47) gemessen. Zusätzlich zu den Originalitems zur allgemeinen Gesundheit (AG) wurden Itemformulierungen zur COVID-19-Infektionsprävention (COVID-19-IP) und frühkindlichen Allergieprävention (FKAP) adaptiert. N = 343 (werdende) Mütter von Kleinkindern beantworteten die Items in einem Online-Assessment. Mittels des WLSMV-Algorithmus wurden konfirmatorische Strukturanalysen durchgeführt. Die Itemmittelwerte variierten deutlich zwischen AG, COVID-19-IP und FKAP (η^2 = .017 – .552). Bifaktor-Modelle wiesen die beste Datenanpassung auf (AG / COVID-19-IP / FKAP: CFI = .964 / .968 / .977; SRMR: .062 / .069 / .035). Der Generalfaktor Zugang determiniert die Iteminformationen am stärksten. Für GH und COVID-19-IP erwiesen sich die drei Subfaktoren Gesundheitsversorgung,

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individuelle Prävention und öffentliche Dienstleistungen als valide; für FKAP Akutversorgung, Unterstützungsleistungen zur Prävention und Präventionsmaßnahmen. Die Unterschiede zwischen GH, COVID-19-IP und FKAP deuten darauf hin, dass die Angaben zum Zugang zu Informationen im HLS-EU nicht nur die Suchkompetenz der (werdenden) Mütter widerspiegeln, sondern auch die Verfügbarkeit bzw. Auffindbarkeit der Gesundheitsinformationen.

Schlüsselwörter: Zugang zu Gesundheitsinformationen, European Health Literacy Survey (HLS-EU), Elterliche Gesundheitskompetenz, COVID-19, Frühkindliche Allergieprävention

Health literate decisions and behaviors require people to have access to valid health information, to understand it, and to evaluate it appropriately regarding their respective life situation (Sørensen et al., 2012). Expectant parents and parents of infants find themselves in a particularly challenging situation, facing a variety of new tasks that affect the health of the child and its long-term development (de Buhr & Tannen, 2020). In this study, we examine how (expectant) mothers of infants assess their ability to obtain helpful health information about different health (prevention) topics: General Health (GH), COVID-19 Infection Prevention (COVID-19-IP), and Early Childhood Allergy Prevention (ECAP).

Health-Literate Access to Information: Personal and Information Characteristics

Parents' skills and abilities to access (i. e., seek, find, and obtain; Sørensen et al., 2012) health-related information represent a fundamental component of parental health literacy (HL). However, being able to access information successfully depends not only on the prior knowledge, skills, and abilities of the parents (HL-related person characteristics); additionally, the quality, accessibility, and the media presence of the information material (information characteristics; Levin-Zamir & Bertschi, 2018) as well as the usability of the media are decisive to successfully gaining helpful information. Moreover, the individual's specific search intention or their information demand and claim also affect search processes (Kayser et al., 2015). Accordingly, the ability to access information on a particular health topic should be systematically influenced by topic-specific characteristics (Gerich & Moosbrugger, 2018; Schulz et al., 2021). For example, the widespread public presence of information on the prevention of COVID-19 infection (COVID-19-IP; "infodemics"; Abel & McQueen, 2020) and the high level of personal responsibility to avoid infections brought personal skills into focus that enable individuals to identify reliable and useful information (Briand et al., 2021). On the one hand, the ubiquitous presence of information should positively support health-literate access to information. On the other hand, it is particularly challenging to distinguish misinformation from reliable information (Diviani et al., 2016). A vaccination sceptic may feel subjectively well informed without this implying orientation to valid information on vaccination (Singh et al., 2022).

In contrast, an information search in the health action domain ECAP (Dresch et al., 2021) is usually triggered by a specific intention and occurs as a targeted action. Access to reliable information on ECAP is more challenging because the evidence base is somewhat unreliable, and prevention recommendations undergo fundamental changes over time ("shift of evidence"; Brunner-Weinzierl & Kopp, 2018), making it difficult to find detailed, helpful information that satisfies the information needs of the searching parents. Accordingly, parents may be expected to rate themselves as more capable of finding information on COVID-19 infections than on ECAP. To date, research on the HL facet Access has not been conducted regarding different application domains. However, identifying moderating effects of health domains could be important to validly assess and evaluate parental health literate Access to health information (facet-specific moderation effects). Furthermore, domain-specific Access may be variably associated with the other HL-construct facets Understand, Appraise, and Apply: Based on existing information processing models (Griffin et al., 1999), one might expect that the association of the individual HL components depends, for example, on the threat experience and the elaborateness of the information processing (moderation correlation strengths in multidimensional HL-process model).

Self-Assessed Ability to Access Information by the European Health Literacy Survey (HLS-EU-Q47)

To investigate the moderating effects of the health (prevention) domains, we assessed the measurement properties of the HL facet Access using the 12 Access items of the HLS-EU-Q47 (Sørensen et al., 2013, 2015) regarding GH, COVID-19-IP, and ECAP in the population of (expectant) mothers of infants. The HLS-EU-Q47 is an internationally established standard for assessing HL, particularly in public health research. The data from the HLS-EU are employed, for example, to document deficits in HL in the population – including international comparisons (Hurrel-

mann et al., 2022). Use of the HLS-EU-Q47 has revealed considerable differences in HL as a function of social status and education (Sørensen et al., 2015).

These content interpretations assume that the HLS-EU-Q47 validly measures the construct of HL and its facets. However, from a psychometric perspective this can be considered critical. The main criticism is that the HLS-EU-Q47 scoring ignores that Access, Understand, Appraise, and Apply are assumed to be separable HL process facets in the theory model. Each of the four facets is represented by a facet-specific item group. The aggregated scoring procedure eliminates the specific information of the conceptually distinct HL facets. Furthermore, Sørensen et al. (2013) distinguished three *fields of action*, which are considered in the formulation of the items of each of the four HLS-EU-Q47 facets: Health Care (medical or clinical issues), Disease Prevention (risk factors for health), and Health Promotion (determinants of health in the social and physical environment). Accordingly, Finbråten et al. (2018) identified a 12-dimension model as the most valid for the HLS-EU-Q47. Although the short versions HLS-Q16 and HLS-Q12 (Finbråten et al., 2018) meet rigorous psychometric quality criteria, for both instruments, the homogeneity of the item pool and thus the unidimensionality of the construct HL is assumed. In contrast to the facet-unspecific analyses of Sørensen et al. (2013; 2015) and Finbråten et al. (2018), in our study we focus on the 12 items of the HLS-EU-Q47 that capture the self-assessed ability to Access health information. The present study examines whether the theoretically distinct HL facet Access is assessed in a psychometrically sound manner in the population of pregnant women and mothers of infants. Because we strive to investigate moderating effects of the health action domains on self-assessed Access skills, we applied the original HLS-EU items and two newly developed domain-specific item versions for COVID-19-IP and ECAP.

Research Questions

The psychometric properties of the HL facet Access of the HLS-EU-Q47 are examined for the population of pregnant women and mothers of infants in the health action domains General Health, COVID-19-IP (Cluver et al., 2020), and ECAP (Dresch et al., 2021). The central questions are:

1. Does self-assessed parental Access vary between the health domains General Health, COVID-19-IP, and ECAP?
2. Are responses to the 12 items of the Access scale determined
   a. by a single latent construct Access (1-DIM model) directly?
   b. by the first-order constructs Health Care, Disease Prevention, and Health Promotion (fields of action), which reflect Access as a second-order construct (2nd order 3-DIM model)?
   c. by both, a general-factor Access and the three constructs Health Care, Disease Prevention, and Health Promotion (fields of action) (bi-factor model)?
3. Are the trait levels of self-assessed Access associated with
   a. the HL facets Understand Health Information as well as Appraise and Apply COVID-19-IP measures?
   b. sociodemographic and allergy- and COVID-19-related characteristics of (expectant) parents?

Methods

Study Sample and Data Collection

The data on HLS-EU-Q47$_{Access}$ and further person characteristics were collected within the project "Structural Modelling and Assessment of HL in Allergy Prevention of New Parents" [GZ: WI-3210/7–1] of the DFG research group "HL in Early Childhood Allergy Prevention: Parental Competencies and Public Health Context in a Shifting Evidence Landscape" [FOR 2959; GZ: AP 235/3–1]. The German Psychological Society gave a positive ethical vote (registration number: MAW 112018), and the study was preregistered at the Leibniz Institute of Psychology (ZPID; Wirtz et al., 2021). The larger research project aims to enhance the conceptual foundation of parental HL in ECAP and COVID-19-IP multidimensionally, developing and validating distinct operationalizations for each of the four HL facets proposed by Sørensen et al. (2012). We investigated this in terms of primary prevention for the population of all parents of infants, regardless of whether there is an individual need, for example, because of an already diagnosed allergic symptomatology in the child or genetic predisposition.

The data were collected using an online questionnaire from May 2021 to February 2022. Initially, we aimed to collect data for both (expectant) parents, but because of the limited participation of men and persons with lower educational attainment, we decided to restrict the recruitment to the female population after the first half of the recruitment and to include mainly women without a university entrance qualification in the study (for details of the recruitment, see Schulz et al., 2022, in this Special Issue).

The final sample includes N = 343 women with a mean age of 32.15 years (SD = 4.72, range 17 to 50 years). N = 281 mothers of infants (mean age of infants: 16.1 months), and n = 62 pregnant women (mean week of gestation: 24.8) constitute the total sample. The proportion of 53 % of (expectant) women with a higher education entrance qualification matches the proportion in the overall female population in Germany in the age range of 25–44 years (Bundesinstitut für Bevölkerungsforschung, 2021). Socioeconomic status is slightly higher in the sample (M = 5.87, SD = 1.42; McArthur Scale) than in the reference standard sample of women aged 18–44 years (M = 5.45, SD = 1.55) (Hoebel et al., 2015). Sample characteristics are shown in detail in ESM 1.

The HLS-EU$_{\text{Access}}$ data analyzed in this article were collected in the same study sample used to develop and validate the HL assessments of Understand Health Information as well as Appraise, and Apply COVID-19-IP measures. Because of the comprehensive assessment, project data were collected in three approximately 45-minute blocks (distance between survey timepoints approx. 10 days). The original HLS-EU$_{\text{Access}}$ and the HLS-EU$_{\text{Access-ECAP}}$ were answered in the first survey block together with sociodemographic and allergy-related characteristics. HL items on Understand Health Information for ECAP were administered in the second survey block. HLS-EU$_{\text{Access-COVID-19}}$ and the COVID-19 specific assessments of Understand Health Information, Appraise, and Apply were answered in the third block.

Measures

HLS-EU-Q47 Facet Access to Health Information (HLS-EU$_{\text{Access}}$)

As outlined above, to date the 12 items of the HLS-EU-Q47 (Sørensen et al., 2013) that capture self-assessed Access to health information have not been analyzed separately. Each item is rated on a 4-point Likert scale: 1 = *very difficult* to 4 = *very easy* (see ESM 2). To record the self-assessed ability to Access information regarding specific prevention areas, we adapted two domain-specific assessments: (1) immediate protection of the family from COVID-19 infections (HLS-EU$_{\text{Access-COVID-19}}$) and (2) long-term protection of the child from allergic diseases (HLS-EU$_{\text{Access-ECAP}}$). Complemented by qualitative prevalidations (N = 16 new or expectant parents), the adaptation for COVID-19 was made by exchanging terms (e.g., disease → corona or corona infection; risk of disease → risk of infection). Because of the special characteristics in the area of ECAP (e.g., item 7: "no vaccination possible," item 11: "low relevance of political decisions"), more distinct contents for single items were adapted (see ESM 2).

HL Assessment Understand Health Information

This objective performance assessment (Schulz et al., 2022; in this Special Issue) was developed and validated using item response theory (IRT; Eid & Schmidt, 2014). The unidimensional, Rasch-homogeneous itembank comprises 57 items, of which each participant completed one-third (test-booklet design). The itembank proved to be consistent across the domains COVID-19 and ECAP. Person-specific estimates of IRT person parameters correspond to weighted likelihood estimates (seperation reliability = .85).

HL Assessment Appraise and Apply COVID-19-IP Measures

Participants indicate (1) how important they consider COVID-19-IP measures for themselves (HL facet Appraise; 21 items reflecting protective measures) and (2) how well they succeed in applying these measures in everyday life (HL facet Apply; 20 items) (Wirtz et al., 2022). The items of the HL facet Appraise proved to be unidimensional (CFI = .96; Cronbach's α = .94). The items of the HL facet Apply represent the 5 factors Apply hygiene measures (Cronbachs α = .73), Avoid contact with other people (α = .78), Avoid public transportation and travel (α = .73), Stay at home (α = .67), and Check infection status (α = .56).

Statistical Analysis

Confirmatory factor analyses (CFA) are conducted using the weighted least square means and variances algorithm for categorical, ordinal data (WLSMV; Flora & Curran, 2004). The WLSMV modeling assumes that the ordinal data can be considered polytomized indicators of continuous latent trait characteristics. The estimation at the level of the normal distributions underlying the manifest data thus implies a correction of scaling effects (e.g., ceiling and floor effects; Ulrich & Wirtz, 2004).

The overall fit of the CFA models proves to be acceptable if the empirically determined variances and covariances of the manifest model variables (empirical information) can be adequately approximated based on the WLSMV parameter estimates (model-based expected information). If the value of the incremental fit measures, confirmatory fit index (CFI) and Tucker-Lewis index (TLI) lies above .95 (acceptable fit) and .97 (good fit), respectively, only a negligible proportion of the data information remains unexplained (Little & Kline, 2016). The standardized root mean square residual (SRMR) and root mean square error of approximation (RMSEA) should be less than .05. Generally, using the WLSMV algorithm meant the SRMR proved to be a more valid fit indicator than the RMSEA (Shi et al., 2020). However, thresholds

Table 1. Descriptive univariate statistics and intercorrelations for the 12 Access items in the domains General Health, ECAP, and COVID-19-IP (N = 343)

	$M^{a)}$ (SD)			ANOVA$^{b)}$		$r^{b)}$		
Find information about …	GH	ECAP	COVID	$F_{(df1;\ df2)}$	part. η^2	GH, ECAP	GH, COVID	ECAP, COVID
1. Disease symptoms	2.96 (0.66)	2.93 (0.67)	**3.75** (0.46)	$284.47_{2.00;\ 684.00}$	.557	.392	.189	.228
2. Therapies for diseases	2.73 (0.70)	2.77 (0.70)	**2.93** (0.80)	$9.74_{1.87;\ 639.31}$	.028	.419	.216	.210
3. Acting in medical emergencies	2.91 (0.70)	2.76 (0.78)	**3.37** (0.69)	$103.48_{1.82;\ 622.54}$	.232	.582	.251	.203
4. Professional help	2.93 (0.73)	2.84 (0.78)	**3.32** (0.74)	$59.36_{1.89;\ 646.31}$	.148	.503	.234	.264
5. Support for unhealthy behavior	**3.02** (0.72)	2.56 (0.71)	2.83 (0.81)	$42.18_{1.96;\ 668.44}$	.110	.296	.175	.220
6. Support for mental problems	**2.57** (0.82)	2.24 (0.78)	2.36 (0.85)	$23.25_{1.87;\ 639.75}$	.064	.520	.280	.308
7. Recommended vaccinations	3.16 (0.73)	3.16 (0.81)	**3.30** (0.73)	$6.03_{1.78;\ 608.89}$	.017	.592	.279	.134
8. Avoiding health risks	2.99 (0.71)	2.67 (0.74)	**3.56** (0.60)	$210.13_{1.98;\ 675.68}$	.381	.412	.165	.268
9. Health promoting behaviors	3.14 (0.64)	3.03 (0.68)	**3.21** (0.76)	$8.56_{1.83;\ 624.85}$	.024	.506	.333	.234
10. Healthy living environment	2.51 (0.74)	2.59 (0.74)	**2.82** (0.86)	$23.08_{1.63;\ 557.95}$	.063	.635	.230	.342
11. Political/scientific changes	2.00 (0.71)	2.30 (0.73)	**2.43** (0.84)	$40.61_{1.89;\ 645.87}$	.106	.401	.220	.348
12. Health promotion offers	2.40 (0.77)	2.41 (0.85)	**2.96** (0.75)	$90.31_{1.82;\ 657.17}$	.209	.585	.299	.272
Total	2.78 (0.47)	2.69 (0.51)	**3.07** (0.49)	$121.01_{1.71;\ 585.70}$	.261	.719	.465	.413

Note. GH = General Health, ECAP = Early Childhood Allergy Prevention, COVID-19-IP = COVID-19 infection prevention; [a)] bold = highest mean values; [b)] $p < .001$ for all test statistics, with the exception of $p < .01$ for $F = 6.03$ (item 7) and $p < .05$ for $r = .134$ (item 7).

for acceptable fit values have been proposed for maximum likelihood estimates assuming multivariate normal distributed data. Because WLSMV tends to overadjust the data information, Xia and Yang (2019) recommend using stricter cut-off values, albeit without specifying these.

Individual items are considered sufficiently reliable if factor loadings are at least .63 or indicator reliabilities are at least .40 (Little & Kline, 2016). The model estimates are calculated with Mplus 8.3 (Muthén & Muthén, 2017). Descriptive scale and item properties and scale correlations are computed with SPSS 28.

Results

Differences in the HL Facet Access Between General Health, COVID-19-IP, and ECAP (Hypothesis 1)

Significant mean differences prevail for each HLS-EU$_{\text{Access}}$ item between the General Health, COVID-19-IP, and ECAP versions (Table 1). 10 % of variance is accounted for by the factor health domain (partial η^2; 2-way-ANOVA with repeated measurement). Access is usually rated best in the domain COVID-19-IP. In particular, information on Disease symptoms (Item 1), Acting in medical emergencies (Item 3), Professional help (Item 4), Avoiding health risks (Item 8), and Health promotion offers (Item 12) are rated as comparatively readily accessible in contrast to the domains GH and ECAP. For the latter two domains, mean values proved to be generally similar. Information on Support for unhealthy behavior and mental problems (item 5, 6) is rated as best accessible for General Health. The ratings for ECAP and COVID-19-IP are noticeably lower here. 24 % of the data variance is explained by item difficulties (main effect item). Additionally, moderating domain effects on item difficulties (interaction item x domain) determine 7 % of the data variance.

Parental self-assessed Access to information on COVID-19-IP correlates only weakly to moderately with self-assessed Access in the domains General Health and ECAP on item level: r = .13-.35 (scale level: r = .47 / .41). In contrast, the correlation of the information on Access to information for General Health and ECAP is considerably higher, r = .30-.64 (scale level: r = .72).

Analysis of the Underlying Dimensional Structure (Hypothesis 2)

According to the global model fit measures (Table 2), the three factorial 2nd-order model is superior to the unidimensional model in all three domains. However, for the HLS-EU$_{\text{Access-General Health}}$ and HLS-EU$_{\text{Access-ECAP}}$ the critical thresholds for acceptable fit are not met even in the 2nd-order 3DIM model (TLI = .906 / .923, CFI = .927 / .940, SRMR = .070 / .056). Moreover, at the local single construct level, the error variance estimates of Factor 2 Disease Prevention are below 0 in each domain, which corresponds to a standardized factor loading exceeding 1.0 on the 2nd-order factor (Table 3).

Table 2. Confirmatory factor analyses for the one-dimensional (1-DIM), three-dimensional (3-DIM), and bi-factor structural models in the three domains General Health, COVID-19, and ECAP

	General health			COVID-19			ECAP		
	TLI	CFI	SRMR	TLI	CFI	SRMR	TLI	CFI	SRMR
1-DIM	.833	.864	.093	.924	.938	.068	.901	.919	.143
3-DIM^{2nd}	.906[a)]	.927[a)]	.070[a)]	.953[a)]	.963[a)]	.055[a)]	.923	.940	.127
3-DIM$^{GH\text{-}2nd\text{-}MOD}$	.912	.932	.066	.944[a)]	.957[a)]	.057[a)]	.917	.936	.057
3-DIM$^{ECAP\text{-}2nd\text{-}MOD}$							.959	.956	.047
Bi-factor$^{GH\text{-}MOD}$	.961	.974	.062	.966	.968	.069	.934	.938	.077
Bi-factor$^{ECAP\text{-}MOD}$							.964	.977	.035

Note. GH = General Health, ECAP = Early Childhood Allergy Prevention, COVID-19-IP = COVID-19 infection prevention; MOD = modified model specification.
[a)] Var(F2) and/or Var(F3) < 0.

Table 3. Standardized factor loadings for the one-dimensional (1-DIM) and three-dimensional (3-DIM 2nd order) structural model for General Health, COVID-19-IP, and ECAP

	General health		COVID-19		ECAP	
	1-Dim	3-Dim	1-Dim	3-Dim	1-Dim	3-Dim
F1: Health care		.672[a)]		.870		.852
1 Disease symptoms	.742	.807	.559	.617	.665	.706
2 Therapies for diseases	.774	.856	.683	.736	.747	.794
3 Acting in medical emergencies	.672	.785	.782	.830	734	.782
4 Professional help	.662	.759	.793	.848	.817	.877
F2: Disease prevention		1.088		1.058		1.031
5 Support for unhealthy behavior	.702	.720	.746	.759	.796	.815
6 Support for mental problems	.689	.704	.722	.734	.708	.720
7 Recommended vaccinations	.569	.578	.587	.596	.548	.557
8 Avoiding health risks	.880	.870	.728	.740	.766	.877
F3: Health promotion		.964		.842		.921
9 Health-promoting behaviors	.872	.885	.784	.848	.761	.801
10 Healthy living environment	.637	.676	.711	.757	.774	.815
11 Political changes	.504	.533	.617	.663	.736	.777
12 Health promotion offers	.642	.677	.699	.749	.598	.631
Latent factor correlations (3-DIM model)						
$r_{\text{Health care, Disease prevention}}$		.731		.921		.879
$r_{\text{Health care, Health promotion}}$		.648		.733		.784
$r_{\text{Disease prevention, Health promotion}}$		1.049		.891		.950

Note. GH = General Health, ECAP = Early Childhood Allergy Prevention, COVID-19-IP = COVID-19 infection prevention. [a)] Standardized loadings of the 1st order factors on the 2nd order factor.

The bi-factor models could not be estimated because of a nonpositive definite variance-covariance matrix. This is expected if misspecifications are already present in the single models combined in the bi-factor model (Wang & Kim, 2017). Both the high intercorrelations between Factor 2 Disease Prevention and Factor 3 Health Promotion (Table 3; esp. $r_{23} > 1.0$) and substantial unexplained residual correlations of the respective indicator items indicate content overlap of the underlying constructs or incorrect assignment of the indicator items.

To identify more valid indicator assignments, we identified and crossvalidated model modifications (randomly split-half: developmental data: $n = 173$; validation data: $n = 170$). Moreover, these model modification steps were performed only for the General Health domain to test the transferability of the identified changes for the other two domains a priorily. The assignment of items 9 ("health-promoting behaviors") and 10 ("healthy living environment") result in considerably better separability of factors 2 and 3 (see ESM 3: development sample: $r_{23} = .83$; validation sample: r_{23}: .67; total sample: r_{23}: .74). Ensuring

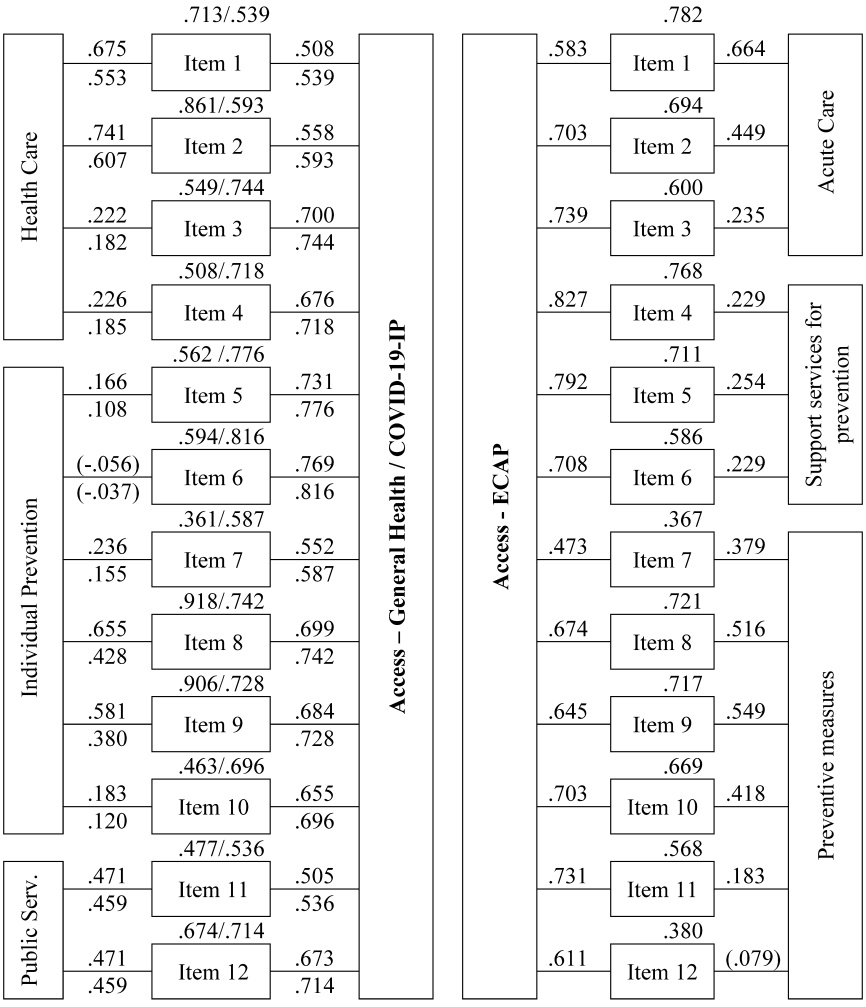

Figure 1. Final bi-factor structural models for Access for General Health and COVID-19-IP (left) and ECAP (right).

the robust separability of the three factors in the modified model bi-factor$^{GH\text{-}MOD}$, an acceptable fit is obtained for the corresponding bi-factor model (TLI = .961, CFI = .974, SRMR = .041; Table 2).

Testing the Validity of the Model Bi-Factor$^{gh\text{-}MOD}$ for COVID-19-IP and ECAP

The bi-factor$^{GH\text{-}MOD}$ structure also proves to transfer well to the COVID-19-IP domain (TLI = .966, CFI = .968, SRMR = .069). Figure 1 plots the loadings of the two models on the left for the General Health and COVID-19-IP domains. All loadings on the common factor Access exceed .5. Only Item 1 ("Disease symptoms") and Item 2 ("Therapy diseases") load higher on Health Care than on the Access common factor.

The good generalizability of the modified model of General Health to COVID-19-IP can be interpreted in terms of the cross-validated stability of the modifications made for General Health. Moreover, this suggests that the factorial structure can be assumed to be stable when accessing information on General Health and COVID-19-IP – despite the considerable item-dependent mean differences (Table 1).

But the bi-factor$^{GH\text{-}MOD}$ structures do not show a satisfactory fit in the ECAP domain (TLI = .934, CFI = .938, SRMR = .077). Furthermore, residual correlations > .25 indicate misspecification in item assignment. Defining and cross-validating appropriate modified item assignments resulted in the three-factor structure shown in Figure 1 (right), assuming the factors Acute care (items 1 to 3), Support services for prevention (items 4 to 6) and Preventive measures (items 7 to 12) prove to be acceptable (3-DIM$^{ECAP\text{-}2nd\text{-}MOD}$ / Bi-factor$^{ECAP\text{-}MOD}$: TLI = .959 / .964; CFI = .956 / 977; SRMR = .047 / .035).

Despite the differences in the three-dimensional structure in General Health / COVID-19-IP vs. ECAP, the overarching Access factor represents the main source of item information in all three domains. The internal consistency of the 12 items is high with McDonald's $\omega_{General\ Health}$ = .874, $\omega_{COVID\text{-}19\text{-}IP}$ = .883, and ω_{ECAP} = .897 (Hayes & Coutts, 2020).

Association of Access Scores with HL Facets and Further Personal Characteristics

Table 4 shows the correlation of the three domain-specific HLS-EU$_{Access}$ total scores with sociodemographic, allergy-related, and COVID-19-related maternal characteristics and further HL facets. The subjectively assessed socioeconomic state (McArthur scale) is positively associated with HLS-EU$_{Access}$ in each domain (General Health: $r = .22$; COVID-19-IP: $r = .21$, *ECAP:* $r = .15$). Women's self-assessed impairment is associated with lower values in HLS-EU$_{Access}$ in the domains General Health and ECAP.

Although the model of Sørensen et al. (2012) defines Access as one of four facets contributing to comprehensive HL, Access proved to be largely independent of the other three factors: Only succeeding in Applying COVID-19 prevention measures in everyday life and Checking COVID-19 infection status were associated (rather weakly) with HLS-EU$_{Access\text{-}COVID\text{-}19\text{-}IP}$.

Discussion

For the first time, this study examined the 12 items of the European Health Literacy Survey (HLS-EU Q47) that capture the health literacy facet Access to health information separately. For both the original items and the items adapted for the health action domains COVID-19-IP and ECAP, the main factor Access is the dominant source of information in a sample of (expectant) mothers. The three versions of the instrument provide the opportunity to differentially capture and examine Access to health information in three health action domains.

According to Hypothesis 1, Access to information on COVID-19-IP is usually rated best. This was expected, because information on COVID-19-IP is readily available and publicly present (Levin-Zamir & Bertschi, 2018). Access to General Health information is rated easiest only for Support for behavioral and mental health problems. As expected, Access to information on ECAP is usually rated most difficult, as this topic not only has little public presence, but there are also fewer reliable and thus less consistent prevention recommendations (Brunner-Weinzierl & Kopp, 2018).

The considerable mean differences in the HLS-EU Access items between the health domains General Health, COVID-19-IP, and ECAP ($\eta^2 = .02\text{-}.56$) reveal an important research desideratum for HL self-assessments (Hurrelmann et al., 2020; Zell & Krizan, 2014). Search competence of a person in the sense of an individual performance disposition (Weinert, 2001) does not exclusively determine search success. In fact, Access to health information is easier when information is more easily accessible (Beaunoyer et al., 2017). Furthermore, self-rated Access skills also depend on whether the quality of the information found meets one's own demands (Lander et al., 2021). Hence, to model individual Access, one should define, assess, and analyze (Diviani et al., 2016) search competence and demand separately (person characteristics; psychological aspect) as well as findability (information characteristics; public health aspect; Freedman et al., 2009). Thus, objective performance assessments (Schulz et al., 2022, in this Special Issue) of personal Access competencies may be beneficial to provide a more valid diagnostic approach to the construct in the sense of search literacy.

Moreover, when people answer the corresponding items of the original HLS-EU$_{Access\text{-}General\ Health}$, they must invoke a certain mental representation that makes General Health or disease subjectively tangible (Faltermaier, 2017). It remains at least partially opaque what respondents actually understand by the term "General Health" or "disease." It seems obvious that the subjectively invoked representation is related to aspects of HL and one's own state of health. If a person has a merely physical concept of health or disease, he or she bases his or her judgment on a different reference than someone who places a high value on psychological or social aspects. A person suffering from an acute or chronic disease might imagine a different reference than someone who perceives his- or herself as completely healthy and resistant to health impairments (Finbråten et al., 2018).

In the confirmatory testing of the HLS-EU-Q47$_{Access}$ scale, bi-factor models combining a general factor Access and three distinct factors prove to be most appropriate (Hypothesis 2) according to global fit measures and the explained item variances. However, the assumption that the three subfactors representing the health action fields of Health Care, Disease Prevention, and Health Promotion must be modified because Disease prevention and Health promotion did not prove to be reliably separable. Defining Health Care, Individual Prevention, and Public Services as latent constructs in the bi-factor model ensures an acceptable model fit for General Health and COVID-19-IP. For ECAP, Acute Care, Support services for prevention, and Preventive measures represent separable subaspects. The specific structure in the domain ECAP could be related to the fact that, for this very long-term prevention objective, health care and preventive action must be understood differently than for health issues associated with the risk of immediate disease (especially in contrast to COVID-19 infection; Dresch et al., 2021). Furthermore, higher uncertainty about indications and developmental courses in allergic diseases or differences in information and support services about ECAP could

Table 4. Internal consistencies of the three HLS-EU Access measures and their correlations with sociodemographic, allergy, and COVID-19-related person characteristics

	GH	COVID-19-IP	ECAP
McDonald's ω (internal consistency)	.874	.883	.897
Age	.071	.062	.044
University entrance qualification[a)]	.122*	.054	.022
MacArthur-Scale (subjective economic state)	**.218*** **	**.210*** **	.146**
Allergy-related characteristics			
Parents affected by allergy[a)]	.027	.091	.000
Child affected by allergy[a)]	-.040	.038	-.043
Self-assessed impairment because of allergies[b,c)]	-.199**	-.002	-.201**
COVID-19-related characteristics			
Vaccinated	.061	.105	.073
I have informed myself about COVID-19[c)]	.112*	.097	.050
I felt burdened by COVID-19[c)]	-.083	-.074	-.052
I had fear of a COVID-19 infection[c)]	-.080	-.057	-.123*
PHL-Understand health information	**.127***	.087	.058
PHL-COVID-19-IP Appraise[c)]	.065	.101	.006
PHL-COVID-19-IP Apply			
Apply hygiene measures	.051	**.185*** **	.036
Avoid contact with other people	.092	.134*	.030
Avoid public transportation & travel	.062	.110*	.047
Stay at home	.075	.125**	.015
Check information status	.139**	**.276*** **	.087

Note. GH = General Health, ECAP = Early Childhood Allergy Prevention, COVID-19-IP = COVID-19 infection prevention. *$p < .05$, **$p < .01$, ***$p < .001$. Bold = still significant after Bonferroni correction (adjusted α for n = 51 tests = .001). [a)] "yes" = "1"; "no" = "0"; [b)] n = 295; [c)] Likert scale (high values = high agreement).

contribute to structural specifics of HLS-EU$_{\text{Access-ECAP}}$ (Brunner-Weinzierl & Kopp, 2018; Dresch et al., 2021).

Despite the differences in the three-factor submodels, for HLS-EU$_{\text{Access-General Health}}$, HLS-EU$_{\text{Access-COVID-19-IP}}$, and HLS-EU$_{\text{Access-ECAP}}$ the general factor Access serves as the main source of information for the 12 indicator items. The aggregated scale values reliably map the construct Access (ω = .874–.897; Table 4) and reflect differences between health action domains with high effect size ($M_{\text{General Health}}$ = 2.78, $M_{\text{COVID-19-IP}}$ = 3.07; M_{ECAP} = 2.69; partial η^2 = .26; Table 1). Accordingly, the computation of a HL facet Access total score can be recommended for HLS-EU$_{\text{Access-General Health}}$, HLS-EU$_{\text{Access-COVID-19-IP}}$, and HLS-EU$_{\text{Access-ECAP}}$. This is in line with the theoretical model and construction rationale of the HLS-EU-Q47, according to which Access represents a central HL facet and the fields of action are of secondary importance (Sørensen et al., 2013, 2015). While Finbråten et al. (2018) only succeeded in identifying the short versions of the HLSE-EU-Q16 and 12 using cross-facet item selection, the findings presented here substantiate the homogeneous and psychometrically sound measurability of the Access facet.

Furthermore, the largely nonsignificant or weak correlations of Access with the other HL facets Understand, Appraise, and Apply suggest a good psychometric separability of the Access facet (Hypothesis 3). Only HLS-EU$_{\text{Access-Covid-19-IP}}$ is notably related to the HL-COVID-19-IP Apply subdimensions Apply hygiene measures (r = .19) and Check information status (r = .28). This good separability particularly questions the validity and psychometric appropriateness of the cross-facet evaluation procedure for the HLS-EU-Q47, -Q16, and -Q12: If both the model and the empirics suggest the distinctiveness of the facets, the subfacets should be surveyed separately to meaningfully analyze and understand the processes underlying health-related decisions (Eid & Schmidt, 2014). Furthermore, Access to information on the health topic COVID-19-IP is considered comparatively easy because of the high public presence. But this does not necessarily imply that people also Understand, Appraise, and Apply this information well. Rather, Hurrelmann et al. (2022) emphasize that the high quantity of information and potentially conflicting and changing COVID-19-IP-related findings and recommendations (e.g., regarding mask-wearing, need for and duration of quarantine) may contribute

to overall uncertainty and thus also to a lower sense of reliable informedness (infodemics, Briand et al., 2021). Moreover, parents who search consciously and more intensively may be more aware of access problems because of the heterogeneity of the content and quality of the information offered.

Access correlates weakly to moderately with socioeconomic status in all three domains (r = .15–.22). This confirms the known positive correlation of social background with HL (Hurrelmann et al., 2020; Sørensen et al., 2015). However, there is no association with educational status (university entrance qualification) in the study population of (expectant) mothers of infants (Hypothesis 3).

Limitations

In addition to the specific limitations of the validity of HL self-reports already mentioned, self-assessments in general can be purposefully influenced by the responders (e.g., self-serving bias, social desirability). Consistency effects (e.g., halo effect) and acquiescence also cannot be ruled out (Dufner et al., 2019). Objective achievement tests, which are more appropriate to capture HL as a competency in terms of achievement disposition, generally only moderately correlate with self-assessments (Zell & Krizan, 2014). The data on General Health and ECAP were collected in the same survey block. COVID-19-IP data were collected approximately 10 days apart, which could have contributed to an enhanced correlation between the health action domains General Health and ECAP compared to COVID-19. Furthermore, women who were more interested in the topic of allergy participated in the study. The parental perspective was analyzed only for (expectant) mothers, although some male partners of the women also participated in the study. Unfortunately, because of the limited participation of fathers, we could not conduct multilevel analysis controlling for dependency within couples. Future studies should additionally examine the perspectives of the (expectant) fathers or the joint couple perspective. The potential moderating effects of gender, social, and educational status should be examined to allow for the fair application and interpretation of the Access scales. Although this is not an epidemiological study, the corresponding limitations of representativeness must be considered when interpreting the results. It must also be considered that, when using the WLSMV algorithm, stricter criteria for good fit should be applied than for the maximum likelihood algorithm (Xia & Yang, 2019). Accordingly, values that fall below the usual cut-off value of .95 for CFI and TLI or exceed the usual cut-off value of .05 for SRMR must be judged as particularly critical (Table 2). Li (2016) found the WLSMV estimates to be less biased than estimates determined by alternative algorithms for ordinal data formats. Although our sample size of N = 343 is larger than the critical sample sizes of N = 200 reported by Li (2016), latent correlations may be slightly overestimated.

In summary, the results contribute to a better comprehension of the psychometric measurement properties of the HLS-EU$_{\text{Access}}$ items and the theoretical understanding of the HL facet Access (Sørensen et al., 2012, 2013). The demonstrated domain dependence of item (esp. item difficulty) and construct properties (specific three-factorial substructure for ECAP) represent an important starting point for further analyses. In particular, the analysis of differential properties of HL facet Access (psychological aspect) in contrast to the availability of health information (public health aspect) is an important research desideratum both for developing theories on HL and the possibility of diagnostic assessment.

Electronic Supplementary Material

The electronic supplementary material is available with the online version of the article at https://doi.org/10.1026/0012-1924/a000295

ESM 1. Study sample characteristics N = 343 (expectant) mothers of infants.

ESM 2. HLS-EU Apply assessment for General health, COVID-19 and ECAP.

ESM 3. Global model fits and latent factor correlations for the structural models in the domains General Health, COVID-19-IP and ECAP.

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Publication Ethics

Written informed consent was obtained from all participants. The German Psychological Society gave a positive ethical vote (registration number: MAW 112018), and the study was preregistered at the Leibniz Institute of Psychology (ZPID) (Wirtz et al., 2021).

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