Health Literacy throughout adolescence: Invariance and validity study of three measurement scales in the general population

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35

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Abstract

53 **Objective**. To simultaneously investigate the psychometric properties of three recently

54 developed health literacy measurement scales throughout adolescence in the general

55 population.

56 **Methods**. French versions of the Health Literacy for School-Aged Children (HLSAC,

57 unidimensional) scale, the Health Literacy Assessment Scale for Adolescents (HAS-A,

58 multidimensional) and the 16-item European Health Literacy Survey questionnaire (HLS-EU-

59 Q16, unidimensional) were completed by 1 444 adolescents in 8th, 9th, 11th grade in general

60 school and 11-12th grade in vocational school. Psychometric properties were studied using

61 confirmatory factor analysis, McDonald's omega coefficient and hypothesis testing.

62 **Results.** Structural validity was acceptable (HLS-EU-Q16) to good (HAS-A and HLSAC), no

63 measurement invariance issue was found and internal consistency was acceptable for the

64 three scales (0.68-0.84). Convergent validity was low (Pearson correlation coefficients<0.5)

65 and the only scale for which results were in agreement with *a priori* hypotheses was the

66 HLSAC.

67 **Conclusions.** Our results were supportive of the use of HLSAC to assess health literacy during

68 adolescence but the HAS-A, with a slightly better structural validity, can also be promoted

69 due to its three measured dimensions.

70 **Practice Implications**. The use of these scales in practice will help to focus on health literacy,

71 a critical factor for prevention and health promotion in adolescence.

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1. Introduction

Health literacy (HL) has been defined as "*the cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand and use information in ways that promote and maintain good health*" [1]. Interest in this concept has been growing in the public health literature since the 2000s, owing to the works of Nutbeam, Osborne et al., or the European HL Survey group, among others, who have developed conceptual models for a more precise understanding of HL [2–4]. All these models encompass the three aspects of the modern conceptualization of HL: *functional HL*, which involves basic skills (reading, writing, etc.) and allows access to health information; *interactive HL*, which uses more advanced cognitive skills to understand this information; and finally *critical HL*, which involves in-depth cognitive and social skills leading ultimately to better control of life events [4].

Several studies have shown links between low HL and poor health status, limited survival, and higher health care costs [5–8]. The central role of HL in health inequities over the world was highlighted by the WHO, which regards HL as "a critical determinant of health" and a resource that "must be an integral part of the skills and competencies developed over a lifetime, first and foremost through the school curriculum" [1,9]. It is becoming increasingly clear that the HL can also be seen as a mediator of health inequalities [10–12]. However, most of the studies on HL have been conducted in adults and very little research, specifically involving the modern conceptualization of HL, have been conducted in adolescents [13–15].

Adolescence is often described as a period of opportunity for prevention and health promotion interventions because fundamental processes of cognitive, physical and emotional development are under construction during this period [10]. It is also at that time

96   that independent decision-making begins [12]. It is therefore crucial to arm adolescents with

97   accurate and reliable health information that can help them adopt healthy behaviors early in

98   life and to continue these behaviors later. Good access to, understanding, critical appraisal

99   and use of such information are thus necessary to enable them to take charge of their own

100 health [12,13]. This is all the more essential in view of the widespread access to information

101 via the Internet, which has raised serious concerns about the correctness and validity of the

102 information that adolescents obtain.

103 A recent systematic review identified 29 HL measurement instruments used in children and

104 adolescents, 15 of which measured all three the HL domains (functional, interactive and

105 critical) [14]. Two of these instruments were brief and designed to be self-administered by

106 adolescents from 13 years of age in general settings: the unidimensional Heath Literacy for

107 School-Aged Children (HLSAC, S1 Table) with 10 items covering five core components of HL

108 (theoretical knowledge, practical knowledge, critical thinking, self-awareness and

109 citizenship), and the multidimensional Health Literacy Assessment Scale for Adolescents

110 (HAS-A, S2 Table) with 15 items related to three dimensions ("Communication:

111 communicating health information", "Confusion: confusion about health information" and

112 "Functional HL: understanding health information") [15,16]. Although these measures have

113 been developed in different samples, their measurement properties appear quite similar,

114 despite some differences in terms of structural validity (more evidence for validity for HAS-A)

115 and hypothesis testing (better agreement with a priori hypotheses for HLSAC). Another well-

116 validated and widely used instrument to measure HL is the (unidimensional) 16-item

117 European Health Literacy Survey (HLS-EU-Q16) [17–19]. This short version of the original 47-

118 item Health Literacy Survey tool covers four health information processing skills (accessing,

119 understanding, appraising, and applying health information) applied to three health contexts

120 (healthcare, disease prevention, and health promotion) (S3 Table) [20]. Although the HLS-

121 EU-Q16 was developed for use among adults in the general population, it has also been used

122 with adolescents [18,19]. However, its measurement properties have never been specifically

123 assessed for use amongst adolescents, and some studies suggest that it may not be well

124 adapted for that purpose [21].

125 In order to enhance the use of HL as a critical factor in prevention and health promotion

126 aimed at adolescents in the general population, this study aimed to investigate the

127 psychometric properties of the HLSAC, HAS-A and HLS-EU-Q16 for use with young people in

128 the age range between 13 to 19 years-old in a sample from the general population. In

129 particular, the purpose was to assess measurement invariance across sex, as it is a

130 characteristic that is almost systematically studied in all studies, and throughout

131 adolescence, to ensure that the scales measure the same construct in an identical way

132 throughout this developmental period, so they can be used to evaluate changes in HL level in

133 longitudinal studies. An additional aim was to assess whether these 3 scales measure

134 different or related HL constructs by investigating convergent validity.

2. Methods

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136 **2.1. Data collected**

137 *2.1.1. French version of the three HL scales*

138 The HLSAC consists of 10 items of the form "I am confident that…", to be scored on 4-point

139 Likert response scales ranging from "not at all true" to "absolutely true", leading to a total

140 score ranging from 10 to 40 (high HL) (S1 Table). Thresholds may be applied to classify HL

141 levels in three categories "low HL" (≤25), "moderate HL" (26 to 35) and "high HL" (>35) [22].

142 In the development study, the Cronbach alpha was 0.93 and a one-factor confirmatory

143 factor analysis (CFA) model had a good fit to the data [15].

144   The HAS-A consists of three subscales: communication, confusion and functional HL,

145   composed of 5, 4 and 6 items respectively. Each item is to be scored on a 5-point Likert

146   response scale leading to 3 subscale scores ranging from 0 to 20 (high communication

147   related HL), 0 to 16 (low confusion related HL) and 0 to 24 (low functional HL) (S2 Table). In

148   the development study, the Cronbach alpha was 0.77, 0.73 and 0.76 for the three subscales,

149   respectively, which had been identified using an exploratory factor analysis [16].

150   The HLS-EU-Q16 consists of 16 items of the format "How difficult is it for you to …", to be

151   scored on 4-point Likert response scales ranging from "very easy" to "very difficult". A total

152   score ranging from 0 to 16 (high HL) is computed by dichotomizing the replies, with the "very

153   easy" and "easy" categories merged into a score of 1 and the "difficult" and "very difficult"

154   merged into 0), and summing the scores thus obtained for the 16 items (S3 Table). Two

155   thresholds are commonly used to define three levels of HL: inadequate (≤8), problematic (>8

156   and ≤12) and adequate (>12)[19,23,24]. Psychometric properties were studied in adults

157   using a Rasch analysis, and Cronbach alpha was 0.81[17,19,23].

158   Five French experts from various disciplines (epidemiology, psychometrics, general

159   medicine, public health, health education) with very high levels of English language

160   proficiency and an English-French translator independently translated the English versions of

161   the HAS-A and HLSAC into French. A consensus meeting was then held to arrive to a

162   consensual French version of the two scales. No back-translation was performed, as this has

163   recently been proven unnecessary [25]. For the HLS-EU-Q16, the French version that had

164   previously been validated for use among adults was used [17] (S1, S2 and S3 Tables).

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167 *2.1.2. Other characteristics*

168 The French version of the three HL scales were compiled in a questionnaire along with

169 questions on socio-demographic characteristics (age, sex, language spoken at home,

170 parents' education), weight and height, and chronic diseases.

171 **2.2. Samples**

172 The protocol, approved by the National Institute of Health and Medical Research (Institut

173 national de la santé et de la recherche médicale - Inserm) ethics review board (IRB00003888,

174 2018/11/12) described three steps in which adolescents were involved. Before the beginning

175 of each step, a letter with information about the study was provided to the adolescent (age-

176 adapted) and to his/her parent(s) (if minor). The adolescent (and/or his/her parents) who

177 did not want to participate to the study provided a signed non-participation form. At the

178 beginning of each step, the study was presented to the adolescent, then each adolescent

179 individually completed the questionnaire (i.e., 3 HL scales and other characteristics) and

180 returned it in an urn in a sealed envelope to preserve anonymity.

181 **2.3. Focus groups**

182 The first step aimed to assess acceptability and comprehensiveness of each translated item

183 of the three HL scales through two focus groups: 1) aged 11-13 years: 7 males, 5 females; 2)

184 aged 14-17 years: 4 males, 6 females. After the completion of the questionnaire (from 15 to

185 35 minutes), a comprehensive discussion was held in each group to identify understanding

186 difficulties and suggestions of change. The consensual French versions of the 3 HL scales

187 were not modified following the focus group however a significant number of

188 comprehension issues was expressed by adolescents aged 11-13 years, particularly

189 concerning the HLS-EU-Q16. The readability level of the translations, assessed using the

190 Flesch Readability Score adapted to texts written in French, was 75.5 (7th grade) for the

191   HLSAC, 63.5 (8th – 9th grade) for the HAS-A, and 48 (undergraduate – bordering end of high-

192   school) for HLS-EU-Q16 [26].

193   **2.4. Pilot testing**

194   The second step aimed to evaluate the quality of questionnaire completion in 4 classes in 3

195   schools in the Paris area (following the focus groups, we decided to remove the 7th grade

196   pupils from the target population): 8th grade (N=27, mean age=13.5 years, 18 males), 9th

197   grade (N=28, mean age=14.5 years, 13 males), 11th grade (N=30, mean age= 16.6 years, 8

198   males) and 11th grade in a vocational school (N=23, mean age=17.7 years, all males). Once all

199   the adolescents had returned the questionnaires, a comprehensive discussion with the

200   whole class was held to assess acceptability of the questionnaire. Only a slight change was

201   made on the item 1 of the HAS-A which began with "Est-il facile pour vous…" ("Is it easy for

202   you…") which was turned in "Est-ce que ça vous arrive de…" ("Do you happen to…") after

203   this pilot testing. Most of the other comments concerned the HLS-EU-Q16 which was

204   considered as too complicated to fill in.

205   **2.5. Study of the psychometric properties**

206   The last step aimed to assess the psychometric properties of the three HL scales in a large

207   sample of adolescents in 8th, 9th, 11th grade in general school and 11-12th grade in vocational

208   school. The minimal sample size was set at 1200 (300 in each grade [27]) and increased by

209   25% due to possible truancy, nonsensical answers to the questionnaire and general setback

210   that could prevent an entire class from completing the questionnaire. To ensure

211   representation (but not statistical representativeness) of the various social backgrounds that

212   exist in France, four geographical areas were chosen in which middle and high-schools were

213   randomly selected, in which classes of each needed grade were randomly selected: Aveyron

214   (rural), Hautes Pyrénées (semi-rural), Haute Garonne (semi-urban), Paris (urban).

2.6. Statistical analyses

Categorical data were summarized as frequencies (%) and quantitative data as means ± standard deviation. Floor or ceiling effects at the scale level were considered to be present if more than 15% of respondents achieved the lowest or highest possible score, respectively [28]. At the item level, these effects were considered to be present if more than 75% answered the lowest or highest response category [29].

The structural validity of each HL scale was studied using confirmatory factor analysis (CFA) with a robust estimator for categorical data, the Weighted Least Square Means and Variances adjusted [30]. For each scale, the model fitted was the one described by the authors of the initial development study: one dimension for HLSAC and HLS-EU-Q16, three dimensions for HAS-A [15,16,23]. Model fit was assessed using the Comparative Fit Index (CFI, good fit if >0.95, poor fit if <0.90, acceptable fit otherwise) and the Root Mean Square Error Approximation (RMSEA, good fit if <0.06, poor fit if >0.1, acceptable fit otherwise) [31].

Measurement invariance was tested consecutively across groups defined by the grade and sex. A multigroup CFA and the classic three-step sequence were used to investigate configural, metric and scalar invariance, i.e. three different nested models having increasing constraints were fitted to test these three levels of invariance [32,33]. For grade invariance for example, the same model was hypothesized in the four grade groups and the sequence of nested model tests was: 1) configural invariance: unconstrained factor loadings and item thresholds; 2) metric invariance: factor loadings constrained to be equal across the four grades and unconstrained item thresholds; 3) scalar invariance: factor loadings and item thresholds constrained to be equal across the four grades. Each level of measurement invariance was considered to be present if the fit indices difference, ΔCFI and ΔRMSEA, between nested models was ≥–0.01 and ≤0.015 respectively [34,35].

239   Internal consistency was assessed using McDonald's omega coefficient (acceptable if ≥0.7)

240   [36]. To assess convergent validity, the correlation between HL scores (and subscale scores)

241   was assessed using Pearson coefficients (acceptable if >0.6) and a weighted kappa

242   coefficient (quadratic weights) was computed to assess concordance (acceptable if

243   kappa>0.6) between the classifications of HL level obtained using HLSAC and HLS-EU-Q16

244   [29,37]. Finally, for hypothesis testing, Cohen's d (corrected for uneven group size if needed)

245   was computed to assess effect size (considered as small if d=0.2, medium if d=0.5 and large if

246   d=0.8) and mean score of each HL scale was compared, using one-way analyses of variance

247   or Student t-tests between adolescents according to sex (*a priori* hypothesis: no difference),

248   grade repetition (lower HL if grade repetition), parents educational level (higher HL for

249   higher education levels), main language at home (higher HL for French), chronic disease

250   (higher HL if chronic disease), weight classification (higher HL if normal weight) [19,38–44].

251   Statistical tests were two-sided and a p-value<0.05 was considered significant. Analyses

252   were performed using Stata v.14 software for data management and basic statistics and

253   Mplus v7.4 software for the CFA, which implements full information maximum likelihood to

254   handle missing data [30,45].

3. Results

256   The survey took place in 68 classes in 23 schools from Monday 9th to Friday 13th March 2020.

257   As the national lockdown due to COVID-19 crisis took place in France the 16th of March, two

258   vocational schools scheduled from Monday 24th to Friday 28th March because adolescents

259   were in internship during the beginning of March could not be included in this study. Among

260   the 1 490 adolescents who filled in the questionnaire, 9 gave nonsensical answers and 37

261   responded to less than half of the items of the three HL scales. The characteristics of the

262   1 444 adolescents included in this study are summarized in the Table 1 according to the

263   grade. The sex-ratio was balanced except in vocational schools in which boys were in

264   majority. A language other than French was spoken at home for a third of the sample and

265   one parent had at least a post-secondary education degree for half of the adolescents.

266   Overall, adolescents were less in overweight or obesity in our sample than in general

267   population (14.7% compared to 18.2% in [46]) and the proportion of adolescents who

268   reported a chronic disease was high (20.8%) but similar with what was found in 2014 in

269   France [47].

Table 1. Characteristics of the sample according to the grade, N(%) unless otherwise stated

	8th grade	9th grade	11th and 12th grades – vocational school	11th grade – general school	Total
N	357	387	285	415	1444
Age (years), median (Q1-Q3)	13 (13-14)	14 (14-15)	17 (16-17)	16 (16-17)	15 (14-16)
Girls	177 (49.6)	203 (52.4)	113 (39.7)	226 (54.5)	719 (49.7)
No grade repetition	331 (93.0)	363 (93.8)	190 (66.7)	368 (88.7)	1252 (86.8)
Live outside the family home	2 (0.6)	5 (1.4)	54 (19.6)	31 (7.6)	92 (6.5)
Main language at home					
· French	215 (60.2)	235 (60.7)	198 (69.5)	299 (72.1)	947 (65.6)
· French and other	128 (35.9)	139 (35.9)	73 (25.6)	107 (25.8)	447 (31.0)
· Other	14 (3.9)	13 (3.4)	14 (4.9)	9 (2.2)	50 (3.5)
Parents education					
· Both parents with high school or lower	58 (16.3)	71 (18.4)	92 (32.3)	70 (16.9)	291 (20.2)
· At least one with post-secondary school	154 (43.1)	202 (52.2)	85 (29.8)	279 (67.2)	720 (49.4)
· Unknown	145 (40.6)	114 (29.5)	108 (37.9)	66 (15.9)	433 (30.0)
Chronic disease	68 (19.4)	69 (18.4)	56 (20.1)	100 (24.6)	293 (20.8)
Weight classification*					
· Under weight	40 (12.8)	42 (11.7)	43 (16.6)	40 (10.0)	165 (12.4)
· Normal weight	234 (74.8)	265 (73.6)	171 (66.0)	311 (77.6)	981 (73.6)
· Overweight	30 (9.6)	45 (12.5)	36 (13.9)	41 (10.2)	152 (11.4)
· Obesity	9 (2.9)	8 (2.2)	9 (3.5)	9 (2.2)	35 (2.6)

271   * Adapted to sex and age, according to the International Obesity Task Force. Q1: first quartile, Q3: third quartile

272

273   The distribution of the answers to each item (of each) of the 3 HL scales is described in S4

274   Table. There was no ceiling or floor effect at the item level and the proportion of missing

275   answers was always <6%. At the scale level, a ceiling effect was observed for the HLS-EU-Q16

276   scale with 269 (21.0%) adolescents with the highest score as described in Fig 1. Concerning

277   structural validity, as shown in Table 2, a good fit was found for the three-dimension HAS-A

278   model while only acceptable to good fit was found for unidimensional HLSAC model and

279   acceptable fit for unidimensional HLS-EU-Q16 model. No measurement invariance issue

280   across grades was found for the three HL scales, neither across sex (Table 2). The internal

281   consistency was acceptable for every scale (nearly acceptable for the HAS-A confusion scale)

282   with a McDonald's omega coefficient was 0.82 for HLSAC, 0.84 for HLS-EU-Q16 and 0.73,

283   0.68 and 0.77 for the communication, confusion and functional HAS-A subscales

284   respectively.

285   **Fig 1. Distribution of the score for the Heath Literacy for School-Aged Children (HLSAC), the**

286   **Health Literacy Assessment Scale for Adolescents (HAS-A) and 16-item European Health**

287   **Literacy Survey (HLS-EU-Q16) scales in the whole sample.**

288 **Table 2. Fit indices of the factor models and study of measurement invariance across grade and sex for the Heath Literacy for School-Aged**

289 **Children (HLSAC), the Health Literacy Assessment Scale for Adolescents (HAS-A) and 16-item European Health Literacy Survey (HLS-EU-Q16).**

Characteristic	Invariance model (constraints)	Chi-square (DF)	CFI	RMSEA (90%CI)	ΔCFI	ΔRMSEA
Grade	**HLSAC**					
	· Configural (no constraints)	504.0 (140)	0.950	0.086 (0.078-0.094)	-	-
	· Metric (loadings)	478.1 (167)	0.957	0.072 (0.065-0.080)	0.007	-0.014
	· Scalar (loadings, thresholds)	578.2 (224)	0.951	0.067 (0.060-0.073)	-0.006	-0.005
	HAS-A					
	· Configural (no constraints)	718.7 (348)	0.961	0.054 (0.049-0.060)	-	-
	· Metric (loadings)	723.9 (384)	0.964	0.050 (0.044-0.055)	0.003	-0.003
	· Scalar (loadings, thresholds)	938.4 (510)	0.954	0.048 (0.043-0.053)	-0.010	-0.002
	HLS-EU-Q16					
	· Configural (no constraints)	1221.4 (416)	0.920	0.074 (0.069-0.078)	-	-
	· Metric (loadings)	1345.9 (461)	0.912	0.073 (0.069-0.078)	-0.008	-0.001
	· Scalar (loadings, intercepts)	1315.4 (527)	0.921	0.065 (0.060-0.069)	0.009	-0.008
Sex	**HLSAC**					
	· Configural (no constraints)	359.7 (70)	0.959	0.076 (0.069-0.084)	-	-
	· Metric (loadings)	324.1 (79)	0.966	0.066 (0.059-0.074)	0.007	-0.010
	· Scalar (loadings, thresholds)	405.1 (98)	0.957	0.066 (0.060-0.073)	-0.009	0.000
	HAS-A					
	· Configural (no constraints)	533.5 (174)	0.962	0.054 (0.048-0.059)	-	-
	· Metric (loadings)	523.1 (186)	0.964	0.050 (0.045-0.055)	0.002	-0.004
	· Scalar (loadings, thresholds)	657.8 (228)	0.954	0.051 (0.047-0.056)	-0.010	0.001
	HLS-EU-Q16					
	· Configural (no constraints)	1012.6 (208)	0.920	0.073 (0.069-0.078)	-	-
	· Metric (loadings)	1018.1 (223)	0.921	0.071 (0.066-0.075)	0.001	-0.002
	· Scalar (loadings, intercepts)	959.5 (246)	0.929	0.064 (0.059-0.068)	0.008	-0.007

290	DF: Degree of Freedom, CFI: Comparative Fit Indices, RMSEA: Root Mean Square Error Approximation, CI: Confidence interval

291 Convergent validity was low. Pearson correlation coefficients between HL scales were all

292 <0.6 (0.40, -0.21, -0.34 and 0.47 between HLSAC and HAS-A communication, confusion,

293 functional subscales and HLS-EU-Q16 respectively; 0.38, -0.29 and -0.36 between HLS-EU-

294 Q16 and HAS-A communication, confusion and functional respectively). The weighted kappa

295 coefficient assessing the concordance between HL levels defined using HLSAC and HLS-EU-

296 Q16 thresholds was equal to 0.24 with 620 (50.5%) adolescents classified as having an

297 adequate HL according to HLS-EU-Q16 while classified as having low or moderate HL

298 according to HLSAC (Table 3). Concerning hypotheses testing, as described in Table 4, the

299 only scale for which results were in agreement with *a priori* hypotheses was the HLSAC with

300 small to medium effect sizes according to Cohen's d (except for grade repetition for which

301 only a tendency was observed). Results concerning the two other scales were rarely in

302 agreement with *a priori* hypotheses.

303 **Table 3. Concordance between health literacy levels according to the Heath Literacy (HL)**

304 **for School-Aged Children (HLSAC) and the 16-item European Health Literacy Survey**

305 **(HLSEU-16) scales. N (%), kappa coefficient=0.1.**

HLSEU-16 (score)	HLSAC (score)		
	Low HL (<26)	Moderate HL (26 to 35)	High HL (>35)
Inadequate HL (<9)	35 (24.1)	38 (4.2)	2 (1.1)
Problematic HL (9 to 12)	64 (44.1)	284 (31.7)	10 (5.5)
Adequate HL (>12)	46 (31.7)	574 (64.1)	170 (93.4)
Total	145 (100.0)	896 (100)	182 (100)

306

Table 4. Hypotheses testing for the School-Aged Children (HLSAC), the Health Literacy Assessment Scale for Adolescents (HAS-A) and the 16-item European Health Literacy Survey (HLS-EU-Q16). *A priori* hypotheses concerning Health Literacy (HL) were: no difference between sex, higher HL in higher grades, higher HL in higher parents' education levels, higher HL for French as main language at home, higher HL if chronic disease, higher HL if normal weight. mean±SD

	HLSAC	HAS-A			HLS-EU-Q16
		Communication	Confusion*	Functional*	
Sex: Cohen d (p-value)	0.07 (0.180)	0.01 (0.887)	0.19 (<0.001)	0.22 (<0.001)	0.12 (0.028)
· Girls	30.4±4.5	13.4±3.4	4.9±3.1	7.4±4.3	12.9±2.7
· Boys	30.7±4.6	13.4±3.4	4.3±3.3	6.4±4.6	13.3±2.5
Grade repetition: Cohen d (p-value)	0.15 (0.076)	0.12 (0.135)	0.01 (0.873)	0.14 (0.080)	0.07 (0.394)
· No	30.6±4.5	13.5±3.4	4.6±3.2	6.8±4.4	13.1±2.5
· Yes	30.0±4.9	13.1±3.9	4.6±3.3	7.5±5.2	13.0±2.8
Parents education: Cohen d (p-value)	0.33 (<0.001)	0.23 (<0.001)	0.14 (0.052)	0.22 (0.002)	0.15 (0.034)
· Both parents ≤high school	30.1±4.7	13.1±3.3	5.0±3.4	7.5±4.9	12.9±2.7
· At least one ≥post-secondary	31.2±4.1	13.9±3.2	4.6±3.2	6.5±4.2	13.3±2.4
Main language at home: largest Cohen d (p-value)	0.56[a] (<0.001)	0.09[b] (0.316)	0.07[a] (0.868)	0.42[a] (0.018)	0.35[a] (0.050)
· French	30.8±4.5	13.5±3.3	4.6±3.1	6.8±4.4	13.2±2.5
· French and other	30.2±4.5	13.2±3.7	4.7±3.3	6.9±4.6	13.0±2.6
· Other	28.1±5.2	13.3±3.4	4.8±3.6	8.7±4.6	12.3±3.1
Chronic disease: Cohen d (p-value)	0.19 (0.006)	0.07 (0.284)	0.11 (0.116)	0.00 (0.961)	0.00 (0.983)
· No	30.4±4.5	13.4±3.4	4.6±3.2	6.9±4.5	13.1±2.6
· Yes	31.2±4.6	13.6±3.5	4.9±3.2	6.9±4.4	13.1±2.5
Weight classification: largest Cohen d (p-value)**	0.30[c] (0.005)	0.11[d] (0.513)	0.16[b] (0.668)	0.15[b] (0.131)	0.18[b] (0.777)
· Under weight	30.7±4.7	13.7±3.4	4.6±3.1	7.3±4.4	13.1±2.5
· Normal weight	30.8±4.4	13.5±3.4	4.6±3.2	6.7±4.5	13.1±2.5

· Overweight	29.6±4.8	13.1±3.7	4.8±3.5	7.5±5.1	13.1±2.7
· Obesity	29.3±3.9	13.1±2.9	5.1±3.0	7.6±4.3	12.7±2.8

311   Statistical tests are Student or anova as appropriate. Cohen'd is corrected for uneven group size if necessary. * Higher scores mean lower HL.

312   **Adapted to sex and age, according to the International Obesity Task Force. Largest Cohen's d between: [a] "French" and "Other", [b] "French"

313   and "French and other", [c] "Normal weight" and "Obesity", [d] "Under weight" and "Obesity"

4. Discussion and conclusion

4.1. Discussion

This study is, to our knowledge, the first one to assess simultaneously the psychometric properties of three recently developed HL scales on the same large sample of adolescents from various social backgrounds. This design of the study allowed to draw the following key results: First, these three scales showed measurement invariance across adolescence from 13 years-old and measurement invariance across sex; Second, convergent validity is low, which means that the HL-related constructs measured by these three scales are different; Third, among the three HL scales, the HLS-EU-Q16 is the one of which the psychometric properties indicate that it is less appropriate for use amongst adolescents (acceptable fit of the CFA model compared to good fit for HAS-A, results rarely in agreement with *a priori* hypotheses compared to always in agreement for HLSAC, undergraduate readability level according to the Flesch Readability Score compared to 7th grade for the HLSAC) .

Measurement invariance is defined by Milsap as "a measuring device should function in the same way across varied conditions, so long as those varied conditions are irrelevant to the attribute being measured" [48]. It is recognized by the COSMIN initiative (COnsensus-based Standards for the selection of health Measurement Instruments) as an important psychometric property as it is closely related to construct validity [49]. Indeed, if a scale lacks of measurement invariance concerning a characteristic, it means that its factor structure is different according to this characteristic and thus, that the scale measures a different construct depending on this characteristic. Due to the developmental processes and changes of cognitive abilities that take place during the adolescence, measurement invariance is clearly important to check throughout the concerned age range whatever the construct

337   being measured. Our study is the first to show that the HLSAC, the HAS-A and the HLS-EU-

338   Q16 scales are invariant throughout adolescence (and also concerning sex) which means that

339   they can be used longitudinally to assess change in HL level during adolescence.

340   However, when assessing convergent validity, it was shown that the scores on these three

341   measures are weakly correlated. This lack of convergent validity is further confirmed by the

342   absence of concordance (weighted kappa=0.24) between the two HL level classifications

343   resulting from the use of the thresholds for HLSAC and HLS-EU-Q16. This means that while

344   these instruments are all supposed to measure HL, they do not measure the same construct.

345   It can be explained by the fact that the authors of each scale were guided by different HL

346   definitions or conceptualizations, even if these three scales are supposed to encompass the

347   three aspects (functional, interactive and critical) of HL. To develop the HAS-A, Manganello

348   *et al.* explained that they used the Berkman's definition of HL ("the degree to which

349   individuals can obtain, process, understand, and communicate about health-related

350   information needed to make informed health decisions") [16,50]. The HL definition used by

351   Sorensen *et al.* to develop the HLS-EU-Q16 is close to the Berkman's definition but

352   "integrates the 'medical' conceptualization of HL with the broader 'public health'

353   perspective of HL" with three domains of application: healthcare, disease prevention, health

354   promotion [51]. Concerning the HLSAC, Paakkari *et al.* indicated that they were interested in

355   HL conceptualized as a learning outcome and developed their tool with "the intention to

356   move beyond HL assessment towards *how* HL can be developed further among the target

357   group"[15]. It is important to be aware of these differences in order to decide which one of

358   these three scales is most suitable for one' s purpose.

359 Finally, while it was hypothesized before the beginning of the data collection which

360 characteristics of the adolescents would be associated with HL, the only measure for which

361 these associations were found was the HLSAC (except for grade repetition maybe due to a

362 lack of power). The effect sizes were small to medium which may indicate a lack of

363 discriminating power for this scale. For the two other scales, the absence of the expected

364 associations may be due to the fact that the measured construct is not the one we expected

365 to measure, or to the presence of a ceiling effect, which could be the case for the HLS-EU-

366 Q16. This effect may decrease the precision of the score, and thus the power to detect

367 expected associations, as it means that the measure is not sufficiently discriminating for a

368 large part of the sample.

369 This study has some limitations. First, the adolescents were asked to complete 3 HL tools,

370 with a total of 41 items that closely resemble each other. This may have reduced their

371 motivation and introduced a form of bias. However, there were very few missing answers to

372 the items of the three instruments, with only 9 participants giving nonsensical answers and

373 only 37 responding to less than half of the items, i.e. 3.1% of the whole sample. Second, we

374 did not assess the sensitivity to change and the test-retest reliability of the measures, which

375 are two important psychometric properties to assess. Further studies should evaluate these

376 properties as they have never been assessed for the HLSAC and the HAS-A [14].

4.2. Conclusion

378 To conclude, the three scales exhibited acceptable to good structural validity and

379 measurement invariance throughout adolescence and across sex. However, the Flesch

380 readability score (7th grade), the internal consistency (Mac Donald omega =0.82) and the

381 hypotheses testing are more in favour of the use of the HLSAC to assess HL during

382   adolescence. On the other hand, the structural validity was slightly better for the HAS-A,

383   which can be interesting as it may bring more analytic information due to the three

384   measured dimensions. While it was not developed specifically for adolescents, the HLS-EU-

385   Q16 could be chosen by some researchers as it could be useful to assess the change of HL

386   level longitudinally throughout adolescence and adulthood. However, it should be

387   considered that some adolescents may have problems understanding all the questions, as

388   was noted during the focus groups and the pilot testing, and the readability Flesch score

389   indicated that it is more suitable for undergraduate students. Moreover, for adolescents

390   there also seems to be an important ceiling effect for this tool, which has also been observed

391   in the adult population [17].

4.3. Practice implications

393   While adolescence is a period of opportunity for prevention and health promotion

394   interventions, very few studies on HL have been conducted in adolescents, partly because of

395   the lack of clear understanding on what is measured by the different existing HL

396   measurement tools over the age span of 13-18 years. This study results clarify that the HL-

397   related constructs measured by the HLSAC, the HAS-A and HLS-EU-Q16 scales are different

398   (low convergent validity) while they all exhibited acceptable to good structural validity and

399   measurement invariance throughout adolescence and across sex. Among the three HL

400   scales, the HLS-EU-Q16 is the one of which the psychometric properties indicate that it is less

401   appropriate for use amongst adolescents. As they are well suited and valid for adolescents

402   from 13 to 19 years-old, the use of the HLSAC and HAS-A in clinical practice and research

403   studies will help to focus on health literacy which is a critical factor for prevention and health

404   promotion interventions in adolescence.

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References

[1]   W.H.O. WHO, Health Literacy. The Solid Facts, (2013). http://www.thehealthwell.info/search-results/health-literacy-solid-facts?&content=resource&member=572160&catalogue=none&collection=none&tokens_complete=true (accessed June 1, 2017).

[2]   R.H. Osborne, R.W. Batterham, G.R. Elsworth, M. Hawkins, R. Buchbinder, The grounded psychometric development and initial validation of the Health Literacy Questionnaire (HLQ), BMC Public Health. 13 (2013) 658. https://doi.org/10.1186/1471-2458-13-658.

[3]   K. Sørensen, S. Van den Broucke, J.M. Pelikan, J. Fullam, G. Doyle, Z. Slonska, B. Kondilis, V. Stoffels, R.H. Osborne, H. Brand, Measuring health literacy in populations: illuminating the design and development process of the European Health Literacy Survey Questionnaire (HLS-EU-Q), BMC Public Health. 13 (2013) 948. https://doi.org/10.1186/1471-2458-13-948.

[4]   D. Nutbeam, The evolving concept of health literacy, Soc Sci Med. 67 (2008) 2072–2078. https://doi.org/10.1016/j.socscimed.2008.09.050.

[5]   Y.I. Cho, S.-Y.D. Lee, A.M. Arozullah, K.S. Crittenden, Effects of health literacy on health status and health service utilization amongst the elderly, Soc Sci Med. 66 (2008) 1809–1816. https://doi.org/10.1016/j.socscimed.2008.01.003.

[6]   S. Mantwill, P. Schulz. Low health literacy associated with higher medication costs in patients with type 2 diabetes mellitus: Evidence from matched survey and health insurance data., Patient Educ Couns. (2015). http://europepmc.org/abstract/med/26198546 (accessed June 1, 2017).

[7]   N.D. Berkman, S.L. Sheridan, K.E. Donahue, D.J. Halpern, K. Crotty, Low health literacy and health outcomes: an updated systematic review, Ann Intern Med 155 (2011) 97–107. https://doi.org/10.7326/0003-4819-155-2-201107190-00005.

444   [8]   S. Bostock, A. Steptoe, Association between low functional health literacy and mortality in older

445   adults: longitudinal cohort study, Brit Med J. 344 (2012) e1602.

446   https://doi.org/10.1136/bmj.e1602.

447   [9]   WHO, Shanghai Declaration on promoting health in the 2030 Agenda for Sustainable

448   Development, in: Health Promotion International, WHO, Geneva, Switzerland, 2017: pp. 7–8.

449   https://www.who.int/publications-detail-redirect/WHO-NMH-PND-17.5 (accessed August 2,

450   2020).

451   [10]   D.L. Borzekowski, Considering children and health literacy: a theoretical approach., Pediatrics.

452   124 Suppl 3 (2009) S282-8. https://doi.org/10.1542/peds.2009-1162D.

453   [11]   J.J. Arnett, Adolescence and Emerging Adulthood: A Cultural Approach, 3 edition, Prentice Hall,

454   Upper Saddle River, NJ, 2006.

455   [12]   J. Manganello, L. Shone, Health Literacy: Research FACTS and findings, ACT for Youth Center of

456   Excellence Ithaca. (2013).

457   [13]   K. Santoro, C. Speedling, The case for investing in youth health literacy: One step on the path to

458   achieving health equity for adolescents, NIHCM Issue Brief. (2011) 1–15.

459   [14]   S. Guo, R. Armstrong, E. Waters, T. Sathish, S.M. Alif, G.R. Browne, X. Yu, Quality of health

460   literacy instruments used in children and adolescents: a systematic review, Brit Med J Open. 8

461   (2018) e020080. https://doi.org/10.1136/bmjopen-2017-020080.

462   [15]   O. Paakkari, M. Torppa, L. Kannas, L. Paakkari, Subjective health literacy: Development of a

463   brief instrument for school-aged children, Scand J Public Health. 44 (2016) 751–757.

464   https://doi.org/10.2307/48512708.

465   [16]   J. Manganello, R.F. DeVellis, T.C. Davis, C. Schottler-Thal, Development of the Health Literacy

466   Assessment Scale for Adolescents (HAS-A), J Commun Healthc. 8 (2015) 172–184.

467   https://doi.org/10.1179/1753807615Y.0000000016.

468   [17]   A. Rouquette, T. Nadot, P. Labitrie, S. Van den Broucke, J. Mancini, L. Rigal, V. Ringa, Validity

469   and measurement invariance across sex, age, and education level of the French short versions

470   of the European Health Literacy Survey Questionnaire, PLOS ONE. 13 (2018).

471   https://doi.org/10.1371/journal.pone.0208091.

472   [18] A.D. Jackson, L. Kirwan, S. Gibney, P. Jeleniewska, G. Fletcher, G. Doyle, Associations between

473   health literacy and patient outcomes in adolescents and young adults with cystic fibrosis, Eur J

474   Public Health. 30 (2020) 112–118. https://doi.org/10.1093/eurpub/ckz148.

475   [19] J. Pelikan, K. Ganahl, S. Van den Broucke, K. Sørensen, Measuring Health Literacy in Europe:

476   Introducing the European Health Literacy Survey Questionnaire (HLS-EU-Q), in: International

477   Handbook of Health Literacy: Research, Practice and Policy across the Lifespan., U. Bauer, O.

478   Okan, P.Pinheiro, D. Levin-Zamir, K. Sørensen, Policy Press, Bristol, 2018.

479   [20] F. Röthlin, J. Pelikan, K. Ganahl, Die Gesundheitskompetenz von 15-jährigen Jugendlichen in

480   Österreich. Abschlussbericht der österreichischen Gesundheitskompetenz Jugendstudie im

481   Auftrag des Hauptverbands der österreichischen Sozialversicherungsträger (HVSV), Ludwig

482   Boltzmann Institut Health Promotion Research (LBIHPR), Wien, Austria, 2013.

483   [21] O.M. Domanska, C. Firnges, T.M. Bollweg, K. Sørensen, C. Holmberg, S. Jordan, Do adolescents

484   understand the items of the European Health Literacy Survey Questionnaire (HLS-EU-Q47) -

485   German version? Findings from cognitive interviews of the project "Measurement of Health

486   Literacy Among Adolescents" (MOHLAA) in Germany, Arch Public Health. 76 (2018) 46.

487   https://doi.org/10.1186/s13690-018-0276-2.

488   [22] O. Paakkari, M. Torppa, J. Villberg, L. Kannas, L. Paakkari, Subjective health literacy among

489   school-aged children, Health Education. 118 (2018) 182–195. https://doi.org/10.1108/HE-02-

490   2017-0014.

491   [23] J.M. Pelikan, Measuring comprehensive health literacy in general populations – The HLS-EU

492   Instrument, (2014).

493   https://www.google.fr/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0ahUKEwi1vZr434

494   rRAhXC7RQKHVsqCrYQFggkMAE&url=http%3A%2F%2Fwww.ahla-

495   asia.org%2Fincludes%2Ffile_down.php%3Ffile%3D..%252Fpublic%252Fperd%252Fchinese%252

496 FPelikan-Taipeh%2BHLS-EU-10-

497 14%2Bfinfin.pdf&usg=AFQjCNEF65mwRACr88iBBMkretzecMQ0RQ&sig2=SjqT7K5zuOGmAfuffI

498 W6iA&cad=rja.

499 [24] J. Pelikan, K. Ganahl, Measuring Health Literacy in General Populations: Primary Findings from

500 the HLS-EU Consortium's Health Literacy Assessment Effort, in: Health Literacy, R.A. Logan and

501 E.R. Siegel (Eds.), IOS Press, n.d.

502 [25] J. Epstein, R.M. Santo, F. Guillemin, A review of guidelines for cross-cultural adaptation of

503 questionnaires could not bring out a consensus, J Clin Epidemiol. 68 (2015) 435–441.

504 https://doi.org/10.1016/j.jclinepi.2014.11.021.

505 [26] V. Ménoni, N. Lucas, J.F. Leforestier, J. Dimet, F. Doz, G. Chatellier, J.-M. Tréluyer, H. Chappuy,

506 The Readability of Information and Consent Forms in Clinical Research in France, PLOS ONE. 5

507 (2010) e10576. https://doi.org/10.1371/journal.pone.0010576.

508 [27] A. Rouquette, B. Falissard, Sample size requirements for the internal validation of psychiatric

509 scales, Int J Methods Psychiatr Res. 20 (2011) 235–249.

510 [28] C.B. Terwee, S.D. Bot, M.R. de Boer, D.A. van der Windt, D.L. Knol, J. Dekker, L.M. Bouter, H.C.

511 de Vet, Quality criteria were proposed for measurement properties of health status

512 questionnaires, J Clin Epidemiol. 60 (2007) 34–42.

513 https://doi.org/10.1016/j.jclinepi.2006.03.012.

514 [29] H.C.W. de Vet, C.B. Terwee, L.B. Mokkink, D.L. Knol, Measurement in Medicine: A Practical

515 Guide, Cambridge University Press, 2011. http://books.google.fr/books?id=_OcdeTg9i28C.

516 [30] L.K. Muthén, B.O. Muthén, (1998-2012). MPlus. Statistical Analysis With Latent Variables.

517 User's Guide. Seventh Edition, (2012).

518 [31] L. Hu, P.M. Bentler, Cutoff criteria for fit indexes in covariance structure analysis: Conventional

519 criteria versus new alternatives, Struct Equ Modeling. 6 (1999) 1–55.

520 https://doi.org/10.1080/10705519909540118.

521   [32]   T.A. Brown, Confirmatory factor analysis for applied research, The Guilford Press, New York,

522   2006.

523   [33]   R.B. Kline, Principles and Practice of Structural Equation Modeling, Third Edition, 3rd edition,

524   The Guilford Press, New York, 2010.

525   [34]   F.F. Chen, Sensitivity of Goodness of Fit Indexes to Lack of Measurement Invariance, Struct Equ

526   Modeling. 14 (2007) 464–504. https://doi.org/10.1080/10705510701301834.

527   [35]   G.W. Cheung, R.B. Rensvold, Evaluating Goodness-of-Fit Indexes for Testing Measurement

528   Invariance, Struct Equ Modeling. 9 (2002) 233–255.

529   https://doi.org/10.1207/S15328007SEM0902_5.

530   [36]   M.W. Watkins, The reliability of multidimensional neuropsychological measures: from alpha to

531   omega, Clin Neuropsychol. 31 (2017) 1113–1126.

532   https://doi.org/10.1080/13854046.2017.1317364.

533   [37]   J.R. Landis, G.G. Koch, The Measurement of Observer Agreement for Categorical Data,

534   Biometrics. 33 (1977) 159–174. https://doi.org/10.2307/2529310.

535   [38]   I. Feinberg, J. Frijters, V. Johnson-Lawrence, D. Greenberg, E. Nightingale, C. Moodie, Examining

536   Associations between Health Information Seeking Behavior and Adult Education Status in the

537   U.S.: An Analysis of the 2012 PIAAC Data, PLOS ONE. 11 (2016) e0148751.

538   https://doi.org/10.1371/journal.pone.0148751.

539   [39]   Asokan G. V.1*, M.Y.A. Yusuf, R. Kirubakaran, A.M.M. Albadwi, A.E. Saad, A.H.S. Mjahed, S.H.

540   Saleh, Levels and Determinants of Health Literacy in Bahrain's Community Context, Oman Med

541   J. 35 (2020) e195. https://doi.org/10.5001/omj.2020.88.

542   [40]   S. Guo, X. Yu, E. Davis, R. Armstrong, E. Riggs, L. Naccarella, Adolescent Health Literacy in

543   Beijing and Melbourne: A Cross-Cultural Comparison, Int J Environ Res Public Health. 17 (2020)

544   1242. https://doi.org/10.3390/ijerph17041242.

545 [41] J.A. Rababah, M.M. Al-Hammouri, B.L. Drew, M. Aldalaykeh, Health literacy: exploring

546 disparities among college students, BMC Public Health. 19 (2019) 1401.

547 https://doi.org/10.1186/s12889-019-7781-2.

548 [42] A. Beauchamp, R. Buchbinder, S. Dodson, R.W. Batterham, G.R. Elsworth, C. McPhee, L.

549 Sparkes, M. Hawkins, R.H. Osborne, Distribution of health literacy strengths and weaknesses

550 across socio-demographic groups: a cross-sectional survey using the Health Literacy

551 Questionnaire (HLQ), BMC Public Health. 15 (2015) 678. https://doi.org/10.1186/s12889-015-

552 2056-z.

553 [43] T. Deliens, P. Clarys, I. De Bourdeaudhuij, B. Deforche, Weight, socio-demographics, and health

554 behaviour related correlates of academic performance in first year university students, Nutr J.

555 12 (2013) 162. https://doi.org/10.1186/1475-2891-12-162.

556 [44] R.L. Rosnow, R. Rosenthal, D.B. Rubin, Contrasts and correlations in effect-size estimation,

557 Psychol Sci. 11 (2000) 446–453. https://doi.org/10.1111/1467-9280.00287.

558 [45] L.P. StataCorp, Stata Statistical Software: Release 14, StataCorp, L.P., College Station, TX, 2015.

559 [46] N. Guignon, M. Delmas, L. Fonteneau, [In 2017, teenagers in better physical health but more

560 often overweight], DREES, Etudes & Résultats. 1122 (2019) 1–6.

561 [47] A. Pacoricona, M. Sentenac, E. Godeau, [The health of middle school students in France / 2014.

562 French data from the international survey Health Behaviour in school-aged children (HBSC)].

563 Handicap et maladie chronique., Santé Publique France. (2016) 4p.

564 [48] R.E. Millsap, Statistical Approaches to Measurement Invariance, 1 edition, Routledge, New

565 York, 2011.

566 [49] L.B. Mokkink, C.B. Terwee, D.L. Patrick, J. Alonso, P.W. Stratford, D.L. Knol, L.M. Bouter, H.C.W.

567 de Vet, The COSMIN study reached international consensus on taxonomy, terminology, and

568 definitions of measurement properties for health-related patient-reported outcomes, J Clin

569 Epidemiol. 63 (2010) 737–745. https://doi.org/10.1016/j.jclinepi.2010.02.006.

570 [50] N.D. Berkman, T.C. Davis, L. McCormack, Health literacy: what is it?, J Health Commun. 15 Suppl

571   2 (2010) 9–19. https://doi.org/10.1080/10810730.2010.499985.

572 [51] K. Sørensen, S. Van den Broucke, J. Fullam, G. Doyle, J. Pelikan, Z. Slonska, H. Brand, Health

573   literacy and public health: A systematic review and integration of definitions and models, BMC

574   Public Health. 12 (2012) 80. https://doi.org/10.1186/1471-2458-12-80.

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577 Supporting information

578 **S1 Table: English and French versions of the Questionnaire with 10 items Health literacy**

579 **for School-Aged Children (HLSAC)**

580 **S2 Table: English and French versions of the 15-item questionnaire Health literacy**

581 **Assessment Scale for Adolescents (HAS-A)**

582 **S3 Table: English and French versions of the European Health Literacy Survey**

583 **Questionnaire with 16 items (HLS-EU-Q16)**

584 **S4 Table: Responses distribution to the 10 items of the Heath Literacy for School-Aged**

585 **Children (HLSAC) according to the grade – N (%)**

586

HLSAC score
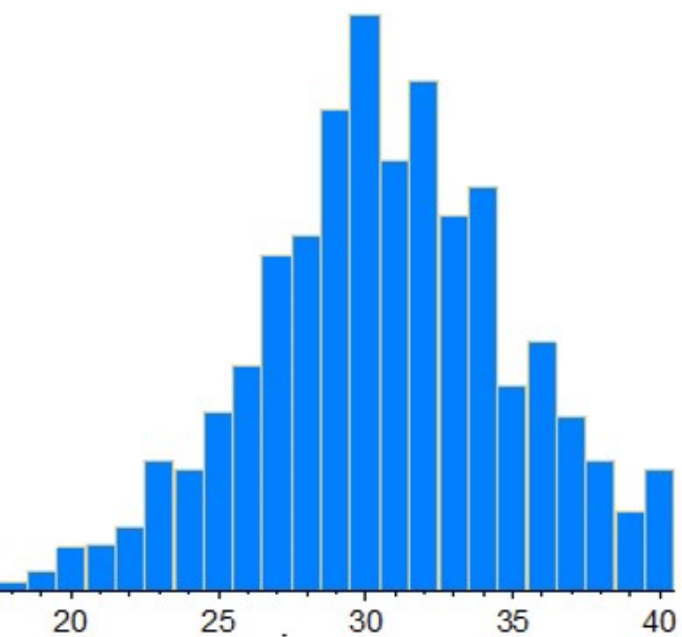
HLSEU-16 score
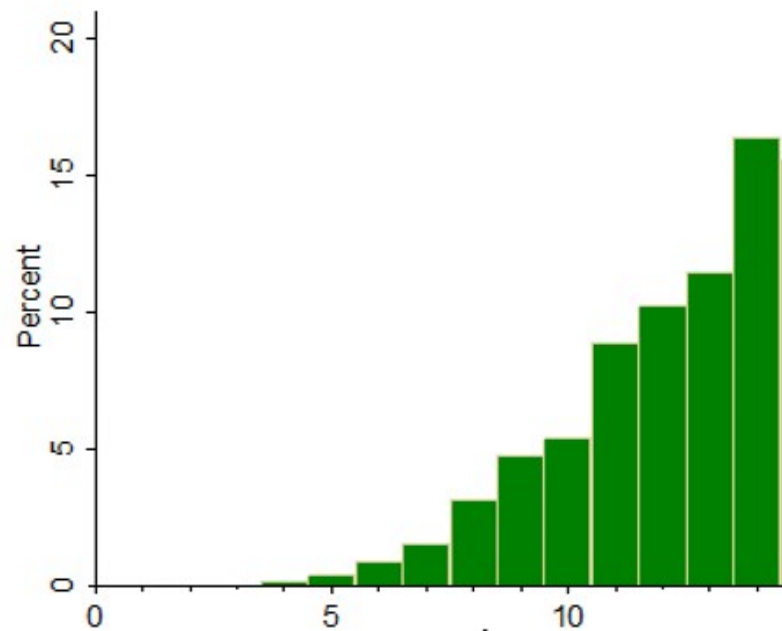
HAS-A

Communication score
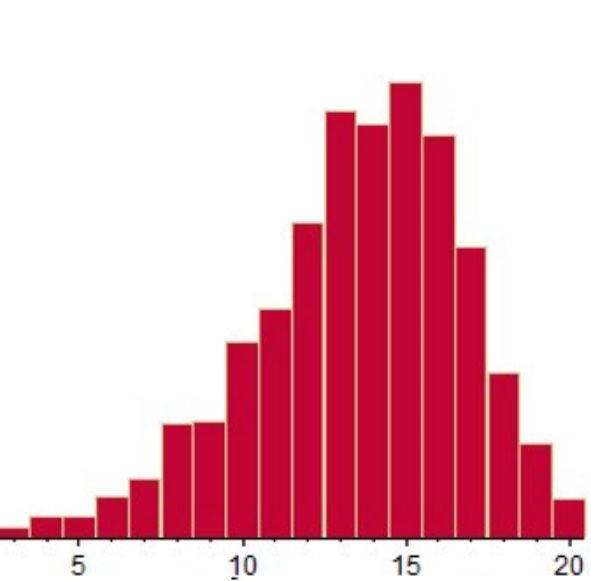
Confusion score
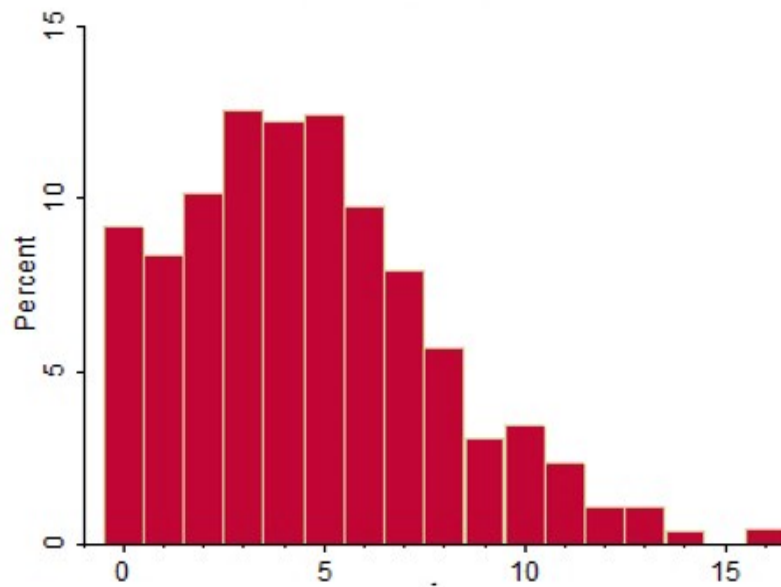
Functional score
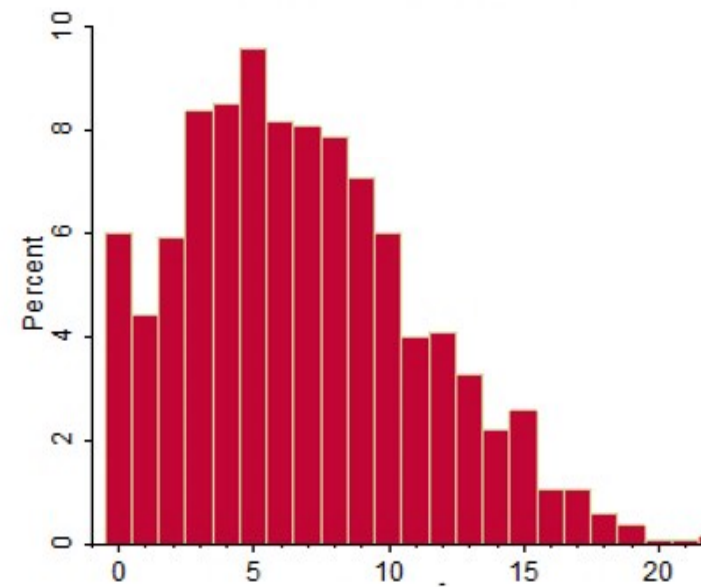
S1 Table. English and French versions of the Health literacy for School-Aged Children (HLSAC) Questionnaire (10 items, unidimensional)

For each item, possible answers are:

- En: **Not at all true / Not completely true / Somewhat true / Absolutely true**
- *Fr* : Pas du tout / Plutôt non / Plutôt oui / Tout à fait

En : **From the following options, choose the one that best describes your opinion**

Fr : Pour chaque proposition, choisissez la réponse qui correspond le mieux à ce que vous pensez

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1

En: **I am confident that I have good information about health**

Fr : Je pense que je suis bien informé sur la santé

2

En: **I am confident that When necessary I am able to give ideas on how to improve health in my immediate surroundings (e.g. a nearby place or area, family, friends)**

Fr : Je pense que si besoin, je suis capable de donner des idées pour améliorer la santé autour de moi (par ex : amis, famille, voisins, quartier)

3

En: **I am confident that I can compare health-related information from different sources**

Fr : Je pense que je sais comparer des informations sur la santé qui viennent de différentes sources (par ex : internet, presse, amis)

4

En: **I am confident that I can follow the instructions given to me by healthcare personnel (e.g. nurse, doctor)**

Fr : Je pense je suis capable de suivre les consignes que me donne le personnel soignant (par ex infirmière, médecin)

5

En: **I am confident that I can easily give examples of things that promote health**

Fr : Je pense que je peux facilement donner des exemples des choses qui sont bonnes ou mauvaises pour la santé

6

En: **I am confident that I can judge how my own actions affect the surrounding natural environment**

Fr : Je pense que je suis capable d'évaluer en quoi mes actions ont un effet sur la nature autour de moi

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S1 Table. Continued

7	En: **I am confident that When necessary I find health-related information that is easy for me to understand**
	Fr : Je pense que si besoin, je trouve des informations sur la santé que je comprends facilement
8	En: **I am confident that I can judge how my behavior affects my health**
	Fr : Je pense que je suis capable d'évaluer en quoi mon comportement à un effet sur ma santé
9	En: **I am confident that I can usually figure out if some health-related information is right or wrong**
	Fr : Je pense que en général, j'arrive à déterminer si une information sur la santé est vraie ou fausse
10	En: **I am confident that I can give reasons for choices I make regarding my health**
	Fr : Je pense que je peux donner les raisons des choix que je fais concernant ma santé

S2 Table. English and French versions of the Health literacy Assessment Scale for Adolescents (HAS-A) questionnaire (15 items, 3 dimensions)

For each item, possible answers are:

- En: **Never / Rarely / Sometimes / Usually / Always**

- *Fr* : Jamais / Rarement / Parfois / Souvent / Toujours

	COMMUNICATION
1	En: **How often is it easy for you to ask your doctor questions about your health?** *Fr :* Est-ce que ça vous arrive de poser des questions sur votre santé à votre médecin ?
2	En: **How often does your doctor understand what you mean when you ask him or her a question about your health?** *Fr :* Est-ce que votre médecin comprend ce que vous voulez dire quand vous lui poser une question ?
3	En: **How often can you easily describe a health problem you have to your doctor?** *Fr :* Est-ce que vous arrivez facilement à décrire votre problème de santé à votre médecin ?
4	En: **How often does your doctor seem to understand you when you answer a question he or she asks?** *Fr :* Est-ce que vous avez l'impression que votre médecin comprend quand vous répondez à ses questions ?
5	En: **How often do you understand the answers your doctor gives to your questions?** *Fr :* Est-ce que vous comprenez les réponses de votre médecin à vos questions ?

	CONFUSION
6	En: **How often do you get confused because you find different information about the same health topic?** *Fr :* Est-ce que ça vous arrive d'être perdu parce que vous avez trouvé des informations différentes sur le même sujet de santé ?
7	En: **How often do you get confused when your doctor tells you about taking a medicine?** *Fr :* Est-ce que ça vous arrive d'être perdu quand votre médecin vous parle d'un médicament à prendre ?

8

En: **How often do you get confused when your doctor tells you about possible side effects from a medicine or treatment?**

Fr : Est-ce que ça vous arrive d'être perdu lorsque votre médecin parle d'effets négatifs possibles d'un traitement ?

9

En: **How often do you get confused when your doctor tells you about test results, like results of an X-ray?**

Fr : Est-ce que ça vous arrive d'être perdu lorsque votre médecin vous donne les résultats d'examens, par exemple une radio ?

FUNCTIONAL HEALTH LITERACY

10

En: **How often do you get confused when reading instructions for medicine?**

Fr : Est-ce que ça vous arrive d'être perdu lorsque vous lisez les consignes pour prendre un médicament ?

11

En: **How often do you have problems learning about an illness or health topic because of difficulty understanding the written information you get?**

Fr : Est-ce que vous avez des problèmes pour vous renseigner sur une maladie ou un sujet de santé parce que l'information écrite que vous trouvez est difficile à comprendre

12

En: **How often do you think the forms you complete at your doctor's office are confusing?**

Fr : Est-ce que les papiers que vous remplissez chez votre médecin vous semblent difficiles à comprendre ?

13

En: **How often are you confused by health information that has a lot of numbers and statistics?**

Fr : Est-ce que ça vous arrive d'être perdu quand il y a beaucoup de chiffres et de pourcentages dans les informations sur la santé ?

14

En: **When you talk to people other than your doctor about health issues, how often are you confused by what they tell you?**

Fr : Quand vous parlez de santé avec d'autres personnes que votre médecin, est-ce que ça vous arrive d'être désorienté parce qu'elles vous disent ?

15

En: **When reading brochures or hand-outs about health issues, how often do you need someone to help you read them?**

Fr : Est-ce que ça vous arrive d'avoir besoin qu'on vous aide à lire des dépliants ou d'autres documents sur la santé ?

S3 Table. English and French versions of the European Health Literacy Survey Questionnaire (HLS-EU-Q16, 16 items, unidimensional)

For each item, possible answers are:
- En: **Very easy / Easy / Difficult / Very difficult**
- *Fr* : Très facile / Facile / Difficile / Très difficile

En: On a scale from very easy to very difficult, how easy would you say it is to…

Fr : Indiquez, sur une échelle de très facile à très difficile, dans quelle mesure il est facile pour vous de...

1	**En**: …find information on treatments of illnesses that concern you? *Fr : …trouver des informations sur les traitements des maladies qui vous concernent ?*
2	**En**: …find out where to get professional help when you are ill? (Ex. such as doctor, nurse, pharmacist, psychologist) *Fr : …savoir où obtenir l'aide d'un professionnel quand vous êtes malade ? (Par ex. médecin, infirmier, pharmacien ou psychologue)*
3	**En**: …understand what your doctor says to you? *Fr : …comprendre ce qu'un médecin vous dit ?*
4	**En**: …understand your doctor's or pharmacist's instruction on how to take a prescribed medicine? *Fr : …comprendre les consignes de votre médecin ou pharmacien sur la manière de prendre vos médicaments ?*
5	**En**: …judge if you may need to get a second opinion from another doctor? *Fr : …savoir quand il serait utile d'avoir l'avis d'un autre médecin ?*
6	**En**: …use information your doctor gives you to make decisions about your illness? *Fr : …utiliser les informations que le médecin vous donne pour prendre des décisions concernant votre maladie ?*
7	**En**: …follow instructions from your doctor or pharmacist? *Fr : …suivre les consignes de votre médecin ou pharmacien ?*
8	**En**: …find information on how to handle mental health problems? (Ex. stress, depression or anxiety) *Fr : …trouver des informations sur comment faire en cas de problèmes psychologiques ? (Par ex. stress, dépression ou anxiété)*

9	**En**: …understand health warnings about behavior such as smoking, low physical activity and drinking too much?
	Fr : …comprendre les mises en gardes concernant l'impact sur la santé de certains comportements comme fumer, ne pas faire assez d'exercice et boire trop ?
10	**En**: …understand information about recommended health screenings or examinations? (Ex. colorectal cancer screening, blood sugar test)
	Fr : …comprendre les informations sur les dépistages et examens recommandés ? (Par ex. dépistage du cancer colorectal, test de glycémie)
11	**En**: …judge if the information on health risks in the mass media is reliable? (Ex. Newspapers, TV or Internet)
	Fr : …évaluer la fiabilité des informations disponibles dans les médias sur ce qui est dangereux pour la santé ? (Par ex. journaux, télévision ou internet)
12	**En**: …decide how you can protect yourself from illness using information from the mass media? (Ex. Newspapers, TV or Internet)
	Fr : …savoir comment vous protéger des maladies à partir des informations disponibles dans les médias ? (Par ex. journaux, télévision ou internet)
13	**En**: …find information about activities that are good for your mental health and well-being? (Ex. relaxation, physical exercise, yoga)
	Fr : …vous renseigner sur les activités bénéfiques pour votre santé et votre bien être ? (Par ex. relaxation, exercice physique, yoga)
14	**En**: …understand advice concerning your health from family or friends?
	Fr : …comprendre les conseils de votre famille ou de vos amis en matière de santé ?
15	**En**: …understand information in the media on how to get healthier?
	Fr : …comprendre les informations disponibles dans les médias pour être en meilleure santé ?
16	**En**: …judge which everyday behavior is related to your health?
	Fr : …identifier quels sont les comportements de votre vie de tous les jours qui ont un impact sur votre santé ?

S4 Table. Responses distribution to the 10 items of the Heath Literacy for School-Aged Children (HLSAC) according to the grade – N (%)

		8th grade	9th grade	11th & 12th grades – vocational school	11th grade – general school	Total
	N	357	387	285	415	1444
HSLAC_1	Not at all true	12 (3.4)	9 (2.3)	14 (4.9)	6 (1.4)	41 (2.8)
	Not completely true	37 (10.4)	41 (10.6)	56 (19.6)	60 (14.5)	194 (13.4)
	Somewhat true	228 (63.9)	269 (69.5)	162 (56.4)	291 (70.1)	950 (65.8)
	Absolutely true	74 (20.7)	62 (16.0)	40 (14.0)	56 (13.5)	232 (16.1)
	Missing	6 (1.7)	6 (1.6)	13 (4.6)	2 (0.5)	27 (1.9)
HSLAC _2	Not at all true	19 (5.3)	30 (7.8)	29 (10.2)	18 (4.3)	96 (6.7)
	Not completely true	75 (21.0)	88 (22.7)	57 (20.0)	81 (19.5)	301 (20.8)
	Somewhat true	205 (57.4)	207 (53.5)	138 (48.4)	238 (57.3)	788 (54.6)
	Absolutely true	49 (13.7)	54 (13.9)	47 (16.5)	74 (17.8)	224 (15.5)
	Missing	9 (2.5)	8 (2.1)	14 (4.9)	4 (1.0)	35 (2.4)
HSLAC _3	Not at all true	26 (7.3)	25 (6.5)	24 (8.4)	14 (3.4)	89 (6.2)
	Not completely true	80 (22.4)	81 (20.9)	40 (14.0)	64 (15.4)	265 (18.3)
	Somewhat true	169 (47.3)	204 (52.7)	158 (55.4)	252 (60.7)	783 (54.2)
	Absolutely true	69 (19.3)	67 (17.3)	50 (17.5)	83 (20.0)	269 (18.6)
	Missing	13 (3.6)	10 (2.6)	13 (4.6)	2 (0.5)	38 (2.6)
HSLAC _4	Not at all true	2 (0.6)	4 (1.0)	6 (2.1)	4 (1.0)	16 (1.1)
	Not completely true	19 (5.3)	9 (2.3)	17 (6.0)	11 (2.6)	56 (3.9)
	Somewhat true	131 (36.7)	134 (34.6)	117 (41.0)	146 (35.2)	528 (36.6)
	Absolutely true	195 (54.6)	231 (59.7)	132 (46.3)	252 (60.7)	810 (56.1)
	Missing	10 (2.8)	9 (2.3)	13 (4.6)	2 (0.5)	34 (2.3)
HSLAC _5	Not at all true	13 (3.6)	7 (1.8)	9 (3.2)	2 (0.5)	31 (2.1)
	Not completely true	40 (11.2)	41 (10.6)	21 (7.4)	32 (7.7)	134 (9.3)
	Somewhat true	167 (46.8)	187 (48.3)	153 (53.7)	179 (43.1)	686 (47.5)
	Absolutely true	123 (34.4)	143 (36.9)	86 (30.2)	199 (47.9)	551 (38.2)
	Missing	14 (3.9)	9 (2.3)	16 (5.6)	3 (0.7)	42 (2.9)
HSLAC _6	Not at all true	19 (5.3)	14 (3.6)	12 (4.2)	7 (1.7)	52 (3.6)
	Not completely true	52 (14.6)	58 (15.0)	47 (16.5)	41 (9.9)	198 (13.7)
	Somewhat true	150 (42.0)	177 (45.7)	128 (44.9)	195 (47.0)	650 (45.0)
	Absolutely true	124 (34.7)	127 (32.8)	84 (29.5)	170 (41.0)	505 (35.0)
	Missing	12 (3.4)	11 (2.8)	14 (4.9)	2 (0.5)	39 (2.7)
HSLAC _7	Not at all true	14 (3.9)	15 (3.9)	6 (2.1)	1 (0.2)	36 (2.5)
	Not completely true	62 (17.4)	52 (13.4)	36 (12.6)	50 (12.0)	200 (13.8)
	Somewhat true	185 (51.8)	219 (56.6)	166 (58.3)	267 (64.3)	837 (58.0)
	Absolutely true	82 (23.0)	91 (23.5)	62 (21.7)	94 (22.6)	329 (22.8)
	Missing	14 (3.9)	10 (2.6)	15 (5.3)	3 (0.7)	42 (2.9)
HSLAC _8	Not at all true	18 (5.0)	18 (4.6)	15 (5.3)	9 (2.2)	60 (4.2)
	Not completely true	51 (14.3)	54 (13.9)	38 (13.3)	45 (10.8)	188 (13.0)
	Somewhat true	174 (48.7)	192 (49.6)	125 (43.9)	207 (49.9)	698 (48.3)
	Absolutely true	102 (28.6)	110 (28.4)	91 (31.9)	152 (36.6)	455 (31.5)
	Missing	12 (3.4)	13 (3.4)	16 (5.6)	2 (0.5)	43 (3.0)
HSLAC _9	Not at all true	25 (7.0)	22 (5.7)	27 (9.5)	19 (4.6)	93 (6.4)
	Not completely true	85 (23.8)	85 (22.0)	68 (23.9)	113 (27.2)	351 (24.3)
	Somewhat true	161 (45.1)	223 (57.6)	135 (47.4)	229 (55.2)	748 (51.8)
	Absolutely true	74 (20.7)	44 (11.4)	41 (14.4)	50 (12.0)	209 (14.5)
	Missing	12 (3.4)	13 (3.4)	14 (4.9)	4 (1.0)	43 (3.0)
HSLAC _10	Not at all true	20 (5.6)	18 (4.6)	24 (8.4)	11 (2.6)	73 (5.1)
	Not completely true	60 (16.8)	73 (18.9)	46 (16.1)	57 (13.7)	236 (16.3)
	Somewhat true	184 (51.4)	199 (51.4)	133 (46.7)	224 (54.0)	740 (51.2)
	Absolutely true	80 (22.4)	86 (22.2)	69 (24.2)	120 (28.9)	355 (24.6)
	Missing	13 (3.6)	11 (2.8)	13 (4.6)	3 (0.7)	40 (2.8)

S4 Table bis. Responses distribution to the 15 items of the Health Literacy Assessment Scale for Adolescents (HAS-A) according to the grade – N (%)

		8th grade	9th grade	11th & 12th grades – vocational school	11th grade – general school	Total
	N	357	387	285	415	1444
HAS-A_1	Never	80 (22.4)	91 (23.5)	86 (30.2)	73 (17.6)	330 (22.9)
	Rarely	110 (30.8)	126 (32.6)	80 (28.1)	134 (32.3)	450 (31.2)
	Sometimes	102 (28.6)	115 (29.7)	74 (26.0)	129 (31.1)	420 (29.1)
	Often	49 (13.7)	36 (9.3)	33 (11.6)	56 (13.5)	174 (12.0)
	Always	11 (3.1)	14 (3.6)	8 (2.8)	22 (5.3)	55 (3.8)
	Missing	5 (1.4)	5 (1.3)	4 (1.4)	1 (0.2)	15 (1.0)
HAS-A_2	Never	13 (3.6)	13 (3.4)	18 (6.3)	13 (3.1)	57 (3.9)
	Rarely	22 (6.2)	17 (4.4)	19 (6.7)	16 (3.9)	74 (5.1)
	Sometimes	43 (12.0)	40 (10.3)	43 (15.1)	52 (12.5)	178 (12.3)
	Often	139 (38.9)	125 (32.3)	87 (30.5)	167 (40.2)	518 (35.9)
	Always	134 (37.5)	183 (47.3)	114 (40.0)	160 (38.5)	591 (40.9)
	Missing	6 (1.7)	9 (2.3)	4 (1.4)	7 (1.7)	26 (1.8)
HAS-A_3	Never	15 (4.2)	11 (2.8)	14 (4.9)	9 (2.2)	49 (3.4)
	Rarely	32 (9.0)	42 (10.8)	28 (9.8)	51 (12.3)	153 (10.6)
	Sometimes	70 (19.6)	79 (20.4)	64 (22.5)	83 (20.0)	296 (20.5)
	Often	122 (34.2)	132 (34.1)	85 (29.8)	170 (41.0)	509 (35.2)
	Always	108 (30.2)	116 (30.0)	89 (31.2)	97 (23.4)	410 (28.4)
	Missing	10 (2.8)	7 (1.8)	5 (1.7)	5 (1.2)	27 (1.9)
HAS-A_4	Never	8 (2.2)	3 (0.8)	10 (3.5)	4 (1.0)	25 (1.7)
	Rarely	17 (4.8)	12 (3.1)	11 (3.9)	11 (2.6)	51 (3.5)
	Sometimes	62 (17.4)	47 (12.1)	46 (16.0)	63 (15.2)	218 (15.1)
	Often	123 (34.4)	163 (42.1)	96 (33.7)	175 (42.2)	557 (38.6)
	Always	140 (39.2)	156 (40.3)	118 (41.4)	159 (38.3)	573 (39.7)
	Missing	7 (2.0)	6 (1.5)	4 (1.4)	3 (0.7)	20 (1.4)
HAS-A_5	Never	7 (2.0)	7 (1.8)	8 (2.8)	3 (0.7)	25 (1.7)
	Rarely	16 (4.5)	13 (3.4)	9 (3.1)	16 (3.9)	54 (3.7)
	Sometimes	67 (18.8)	76 (19.6)	60 (21.1)	68 (16.4)	271 (18.8)
	Often	137 (38.4)	155 (40.0)	116 (40.7)	198 (47.7)	606 (42.0)
	Always	125 (35.0)	128 (33.1)	85 (29.6)	127 (30.6)	465 (32.2)
	Missing	5 (1.4)	8 (2.1)	7 (2.54)	3 (0.7)	23 (1.6)
HAS-A_6	Never	102 (28.6)	94 (24.3)	62 (21.8)	61 (14.7)	319 (22.1)
	Rarely	84 (23.5)	103 (26.6)	59 (20.7)	96 (23.1)	342 (23.7)
	Sometimes	100 (28.0)	112 (28.9)	88 (30.9)	158 (38.1)	458 (31.7)
	Often	48 (13.4)	56 (14.5)	49 (17.2)	80 (19.3)	233 (16.1)
	Always	15 (4.2)	12 (3.1)	18 (6.3)	17 (4.1)	62 (4.3)
	Missing	8 (2.2)	10 (2.6)	9 (3.2)	3 (0.7)	30 (2.1)
HAS-A_7	Never	167 (46.8)	183 (47.3)	113 (39.6)	145 (34.9)	608 (42.1)
	Rarely	100 (28.0)	99 (25.6)	75 (26.3)	163 (39.3)	437 (30.3)
	Sometimes	53 (14.9)	61 (15.8)	62 (21.7)	70 (16.9)	246 (17.0)
	Often	19 (5.3)	28 (7.2)	23 (8.1)	30 (7.2)	100 (6.9)
	Always	9 (2.5)	9 (2.3)	6 (2.1)	5 (1.2)	29 (2.0)
	Missing	9 (2.5)	7 (1.8)	6 (2.1)	2 (0.5)	24 (1.7)
HAS-A_8	Never	140 (39.2)	171 (44.2)	112 (39.3)	150 (36.1)	573 (39.7)
	Rarely	95 (26.6)	99 (25.6)	68 (23.9)	145 (34.9)	407 (28.2)
	Sometimes	74 (20.7)	66 (17.0)	49 (17.2)	72 (17.3)	261 (18.1)
	Often	28 (7.8)	30 (7.7)	32 (11.2)	34 (8.2)	124 (8.6)
	Always	9 (2.5)	13 (3.4)	15 (5.3)	10 (2.4)	47 (3.2)
	Missing	11 (3.1)	8 (2.1)	9 (3.2)	4 (1.0)	32 (2.2)

HAS-A_9	Never	161 (45.1)	174 (45.0)	132 (46.3)	154 (37.1)	623 (43.0)
	Rarely	82 (23.0)	90 (23.3)	44 (15.4)	129 (31.1)	345 (23.9)
	Sometimes	68 (19.0)	68 (17.6)	45 (15.8)	59 (14.2)	240 (16.6)
	Often	25 (7.0)	30 (7.7)	32 (11.2)	58 (14.0)	145 (10.0)
	Always	11 (3.1)	17 (4.4)	25 (8.8)	13 (3.1)	66 (4.6)
	Missing	10 (2.8)	8 (2.1)	7 (2.5)	2 (0.5)	27 (1.9)
HAS-A_10	Never	154 (43.1)	164 (42.4)	109 (38.2)	128 (30.8)	555 (38.4)
	Rarely	86 (24.1)	111 (28.7)	75 (26.3)	140 (33.7)	412 (28.5)
	Sometimes	64 (17.9)	67 (17.3)	51 (17.9)	95 (22.9)	277 (19.2)
	Often	29 (8.1)	22 (5.7)	25 (8.8)	39 (9.4)	115 (8.0)
	Always	19 (5.3)	18 (4.6)	19 (6.7)	11 (2.6)	67 (4.6)
	Missing	5 (1.4)	5 (1.3)	6 (2.1)	2 (0.5)	18 (1.2)
HAS-A_11	Never	130 (36.4)	145 (37.5)	86 (30.2)	97 (23.4)	458 (31.7)
	Rarely	100 (28.0)	121 (31.3)	78 (27.4)	150 (36.1)	449 (31.1)
	Sometimes	78 (21.8)	88 (22.7)	75 (26.3)	119 (28.7)	360 (24.9)
	Often	33 (9.2)	20 (5.2)	24 (8.4)	38 (9.2)	115 (8.0)
	Always	7 (2.0)	7 (1.8)	14 (4.9)	7 (1.7)	35 (2.4)
	Missing	9 (2.5)	6 (1.5)	8 (2.8)	4 (1)	27 (1.9)
HAS-A_12	Never	139 (38.9)	146 (37.7)	93 (32.6)	136 (32.8)	514 (35.6)
	Rarely	106 (29.7)	123 (31.8)	98 (34.4)	155 (37.3)	482 (33.4)
	Sometimes	61 (17.1)	79 (20.4)	52 (18.2)	84 (20.2)	276 (19.1)
	Often	25.0 (7.0)	27 (7.0)	24 (8.4)	30 (7.2)	106 (7.3)
	Always	12 (3.4)	6 (1.5)	12 (4.2)	7 (1.7)	37 (2.6)
	Missing	14 (3.9)	6 (1.5)	6 (2.1)	3 (0.7)	29 (2.0)
HAS-A_13	Never	92 (25.8)	111 (28.7)	57 (20.0)	102 (24.6)	362 (25.1)
	Rarely	89 (24.9)	86 (22.2)	56 (19.6)	139 (33.5)	370 (25.6)
	Sometimes	85 (23.8)	108 (27.9)	83 (29.1)	88 (21.2)	364 (25.2)
	Often	50 (14.0)	56 (14.5)	47 (16.5)	62 (14.9)	215 (14.9)
	Always	28 (7.8)	21 (5.4)	35 (12.3)	22 (5.3)	106 (7.3)
	Missing	13 (3.6)	5 (1.3)	7 (2.5)	2 (0.5)	27 (1.9)
HAS-A_14	Never	125 (35.0)	131 (33.8)	73 (25.6)	90 (21.7)	419 (29.0)
	Rarely	93 (26.0)	110 (28.4)	99 (34.7)	149 (35.9)	451 (31.2)
	Sometimes	85 (23.8)	94 (24.3)	63 (22.1)	133 (32.0)	375 (26.0)
	Often	33 (9.2)	38 (9.8)	21 (7.4)	34 (8.2)	126 (8.7)
	Always	10 (2.8)	9 (2.3)	23 (8.1)	6 (1.4)	48 (3.3)
	Missing	11 (3.1)	5 (1.3)	6 (2.1)	3 (0.7)	25 (1.7)
HAS-A_15	Never	177 (49.6)	203 (52.4)	154 (54.0)	246 (59.3)	780 (54.0)
	Rarely	71 (19.9)	84 (21.7)	56 (19.6)	105 (25.3)	316 (21.9)
	Sometimes	50 (14.0)	61 (15.8)	35 (12.3)	44 (10.6)	190 (13.2)
	Often	34 (9.5)	23 (5.9)	18 (6.3)	12 (2.9)	87 (6.0)
	Always	13 (3.6)	10 (2.6)	15 (5.3)	6 (1.3)	44 (3.0)
	Missing	12 (3.4)	6 (1.5)	7 (2.5)	2 (0.5)	27 (1.9)

S4 Table ter. Responses distribution to the 16 items of the European Health Literacy Survey (HLS-EU-Q16) according to the grade – N (%)

		8th grade	9th grade	11th & 12th grades – vocational school	11th grade – general school	Total
	N	357	387	285	415	1444
	Very easy	93 (26.0)	99 (25.6)	60 (21.1)	111 (26.8)	363 (25.1)
	Easy	195 (54.6)	223 (57.6)	176 (61.8)	258 (62.2)	852 (59.0)
HLSEU_1	Difficult	48 (13.4)	52 (13.4)	32 (11.2)	37 (8.9)	169 (11.7)
	Very difficult	5 (1.4)	3 (0.8)	8 (2.8)	0 (0)	16 (1.1)
	Missing	16 (4.5)	10 (2.6)	9 (3.2)	9 (2.2)	44 (3.1)
	Very easy	175 (49.0)	178 (46.0)	103 (36.1)	211 (50.8)	667 (46.2)
	Easy	150 (42.0)	177 (45.7)	153 (53.7)	174 (41.9)	654 (45.3)
HLSEU_2	Difficult	26 (7.3)	28 (7.2)	17 (6.0)	26 (6.3)	97 (6.7)
	Very difficult	2 (0.6)	0 (0)	2 (0.2)	0 (0)	4 (0.3)
	Missing	4 (1.1)	4 (1.0)	10 (3.5)	4 (1.0)	22 (1.5)
	Very easy	150 (42.0)	140 (36.2)	89 (31.2)	153 (36.9)	532 (36.9)
	Easy	173 (48.5)	212 (54.8)	162 (56.8)	228 (54.9)	775 (53.7)
HLSEU_3	Difficult	29 (8.1)	30 (7.7)	19 (6.7)	30 (7.2)	108 (7.5)
	Very difficult	1 (0.3)	2 (0.5)	2 (0.7)	0 (0)	5 (0.3)
	Missing	4 (1.1)	3 (0.8)	13 (4.5)	4 (1.0)	24 (1.7)
	Very easy	213 (59.7)	228 (58.9)	154 (54.0)	248 (59.8)	843 (58.4)
	Easy	127 (35.6)	145 (37.5)	111 (39.0)	151 (36.4)	534 (37.0)
HLSEU_4	Difficult	7 (2.0)	9 (2.3)	11 (3.9)	9 (2.2)	36 (2.5)
	Very difficult	5 (1.4)	1 (0.3)	0 (0)	2 (0.5)	8 (0.6)
	Missing	5 (1.4)	4 (1.0)	9 (3.2)	5 (1.2)	23 (1.6)
	Very easy	46 (12.9)	69 (17.8)	39 (13.7)	55 (13.3)	209 (14.5)
	Easy	180 (50.4)	164 (42.4)	114 (40.0)	176 (42.4)	634 (43.9)
HLSEU_5	Difficult	107 (30.0)	125 (32.3)	107 (37.5)	158 (38.1)	497 (34.4)
	Very difficult	10 (2.8)	18 (4.6)	13 (4.5)	18 (4.3)	59 (4.1)
	Missing	14 (3.9)	11 (2.8)	12 (4.2)	8 (1.9)	45 (3.1)
	Very easy	99 (27.7)	90 (23.3)	69 (24.2)	91 (21.9)	349 (24.2)
	Easy	174 (48.7)	213 (55.0)	148 (51.9)	232 (55.9)	767 (53.0)
HLSEU_6	Difficult	62 (17.4)	62 (16.0)	51 (17.9)	80 (19.3)	255 (17.7)
	Very difficult	8 (2.2)	13 (3.4)	7 (2.5)	6 (1.5)	34 (2.4)
	Missing	14 (3.9)	9 (2.3)	10 (3.5)	6 (1.5)	39 (2.7)
	Very easy	224 (62.8)	214 (55.3)	145 (50.9)	233 (56.2)	816 (56.5)
	Easy	111 (31.1)	156 (40.3)	115 (40.4)	162 (39.0)	544 (37.7)
HLSEU_7	Difficult	13 (3.6)	10 (2.6)	15 (5.3)	13 (3.1)	51 (3.5)
	Very difficult	2 (0.6)	1 (0.3)	1 (0.4)	3 (0.7)	7 (0.5)
	Missing	7 (2.0)	6 (1.5)	9 (3.2)	4 (1.0)	26 (1.8)
	Very easy	68 (19.0)	78 (20.2)	55 (19.3)	72 (17.4)	273 (18.9)
	Easy	134 (37.5)	136 (35.1)	104 (36.5)	156 (37.6)	530 (36.7)
HLSEU_8	Difficult	109 (30.5)	122 (31.5)	88 (30.9)	142 (34.2)	461 (31.9)
	Very difficult	31 (8.7)	41 (10.6)	24 (8.4)	34 (8.2)	130 (9.0)
	Missing	15 (4.2)	10 (2.6)	14 (4.9)	11 (2.7)	50 (3.5)
	Very easy	223 (62.5)	221 (57.1)	128 (44.9)	235 (56.6)	807 (55.9)
	Easy	107 (30.0)	120 (31.0)	108 (37.9)	145 (34.9)	480 (33.2)
HLSEU_9	Difficult	14 (3.9)	31 (8.0)	28 (9.8)	24 (5.8)	97 (6.7)
	Very difficult	6 (1.7)	6 (1.5)	10 (3.5)	7 (1.7)	29 (2.0)
	Missing	7 (2.0)	9 (2.3)	11 (3.9)	4 (1.0)	31 (2.2)

S4 Table ter. Continued

		8th grade	9th grade	11th & 12th grades – vocational school	11th grade – general school	Total
	N	357	387	285	415	1444
HLSEU_10	Very easy	127 (35.6)	157 (40.6)	139 (48.8)	247 (59.5)	670 (46.4)
	Easy	158 (44.3)	153 (39.5)	104 (36.5)	135 (32.5)	550 (38.1)
	Difficult	54 (15.1)	56 (14.5)	28 (9.8)	25 (6.0)	163 (11.3)
	Very difficult	6 (1.7)	15 (3.9)	4 (1.4)	4 (1.0)	29 (2.0)
	Missing	12 (3.4)	6 (1.5)	10 (3.5)	4 (1.0)	32 (2.2)
HLSEU_11	Very easy	97 (27.2)	72 (18.6)	48 (16.8)	60 (14.5)	277 (19.2)
	Easy	156 (43.7)	183 (47.3)	144 (50.5)	178 (42.9)	661 (45.8)
	Difficult	91 (25.5)	107 (27.6)	67 (23.5)	153 (36.9)	418 (28.9)
	Very difficult	6 (1.7)	15 (3.9)	12 (4.2)	20 (4.8)	53 (3.7)
	Missing	7 (2.0)	10 (2.6)	14 (4.9)	4 (1.0)	35 (2.4)
HLSEU_12	Very easy	90 (25.2)	84 (21.7)	75 (26.3)	78 (18.8)	327 (22.6)
	Easy	191 (53.5)	198 (51.2)	137 (48.1)	223 (53.7)	749 (51.9)
	Difficult	61 (17.1)	85 (22.0)	55 (19.3)	94 (22.6)	295 (20.4)
	Very difficult	7 (2.0)	9 (2.3)	6 (2.1)	15 (3.6)	37 (2.6)
	Missing	8 (2.2)	11 (2.8)	12 (4.2)	5 (1.2)	36 (2.5)
HLSEU_13	Very easy	98 (27.4)	87 (22.5)	71 (24.9)	118 (28.4)	374 (25.9)
	Easy	173 (48.5)	188 (48.6)	124 (43.5)	186 (44.8)	671 (46.5)
	Difficult	69 (19.3)	77 (19.9)	62 (21.7)	91 (21.9)	299 (20.7)
	Very difficult	4 (1.1)	23 (5.9)	11 (3.9)	14 (3.4)	52 (3.6)
	Missing	13 (3.6)	12 (3.1)	17 (6.0)	6 (1.4)	48 (3.3)
HLSEU_14	Very easy	201 (56.3)	179 (46.3)	112 (39.3)	180 (43.4)	672 (46.5)
	Easy	129 (36.1)	175 (45.2)	129 (45.3)	197 (47.5)	630 (43.6)
	Difficult	17 (4.8)	23 (5.9)	28 (9.8)	28 (6.7)	96 (6.6)
	Very difficult	2 (0.6)	4 (1.0)	6 (2.1)	6 (1.4)	18 (1.2)
	Missing	8 (2.2)	6 (1.5)	10 (3.5)	4 (1.0)	28 (1.9)
HLSEU_15	Very easy	105 (29.4)	102 (26.4)	65 (22.8)	93 (22.4)	365 (25.3)
	Easy	187 (52.4)	216 (55.8)	143 (50.2)	241 (58.1)	787 (54.5)
	Difficult	46 (12.9)	55 (14.2)	60 (21.0)	70 (16.9)	231 (16.0)
	Very difficult	9 (2.5)	6 (1.5)	7 (2.5)	6 (1.4)	28 (1.9)
	Missing	10 (2.8)	8 (2.1)	10 (3.5)	5 (1.2)	33 (2.3)
HLSEU_16	Very easy	111 (31.1)	120 (31.0)	80 (28.1)	133 (32.0)	444 (30.7)
	Easy	158 (44.3)	167 (43.1)	135 (47.4)	184 (44.3)	644 (44.6)
	Difficult	64 (17.9)	71 (18.3)	47 (16.5)	73 (17.6)	255 (17.7)
	Very difficult	14 (3.9)	20 (5.2)	12 (4.2)	16 (3.9)	62 (4.3)
	Missing	10 (2.8)	9 (2.3)	11 (3.9)	9 (2.2)	39 (2.7)