ORAL HEALTH LITERACY IN ADOLESCENTS: BARRIERS TO EFECTIVE PREVENTIVE DENTAL CARE AND INTEGRATIVE STRATEGIES

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ABSTRACT

Aim of the study The study highlights the critical role of oral health literacy in shaping oral health outcomes among vulnerable populations. Its objectives were to assess the relationship between health literacy and oral health literacy among adolescents, as well as the impact of individual factors on literacy levels. **Materials and methods** A cross-sectional study on 58 participants (mean age 13.72 ± 0.98) from a high school in Bucharest, Romania was conducted in October 2020. The oral health literacy was evaluated through the Romanian version of the REALD-30, while two instruments assessed health literacy: the REALM-Teen, and the REALM-R. A written questionnaire collected demographic information and participants' self-assessment of health status, access to dental services, reasons for dental visits and sources of information for oral health. IBM SPSS Statistics 25 was used for data analysis, with quantitative variables tested through Shapiro-Wilk, Mann-Whitney, and Kruskal-Wallis H tests ($p \leq 0.05$). Spearman's rho assessed correlations, Fisher's Exact test evaluated qualitative variables, and Cohen's kappa measured consistency between REALM-Teen and REALM-R scores. **Results** Positive correlation between REALM-Teen, REALM-R and REALD-30 was recorded. The most achieved high REALM-Teen (62.64 ± 2.62) and REALM-R levels (7.5 ± 0.7), while almost a half registered high REALD-30 levels (24.97 ± 3.13), with significant associations between REALM-Teen and REALD-30 levels ($p = 0.002$) and REALM-R and REALD-30 levels ($p = 0.029$). Higher REALM-Teen levels ($p = 0.025$) were significantly correlated with younger teenagers, while average REALD-30 levels associated the usage of Internet as a source of information ($p = 0.011$). **Conclusions** There is an association between OHL and HL during early adolescence. However, the predictors of OHL in adolescents may differ from those in other group populations, the study highlighting the need for age-appropriate tools to assess OHL and targeted interventions to improve HL in this group.

Key words: health literacy, oral health, healthcare, adolescence, adolescent behaviors, health education, preventive dentistry, public health dentistry

INTRODUCTION

Among many communities, the connection between oral health knowledge, healthcare practices, and the severity of oral diseases undoubtedly persists. This is why one of the key preventive strategies of the last decades of the World Health Organization (WHO) Global Oral Health Program for improving oral focuses on oral health literacy (OHL) [1] Derived from the previously more intensively investigated concept of health literacy (HL) among global populations, the term OHL was defined by the US Department of Health and Human Services in its report "Healthy People 2010" as "the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate oral health decisions" [2]. It is also a social determinant of health, alongside other predictors such as socioeconomic status, education, income, and

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language [3], reflecting the individual's ability to understand and use dental information and subsequently transforms it into healthy oral behaviors. The relationship between OHL and HL is highly interconnected, each significantly influencing health behaviors. Studies have shown that higher levels of OHL are associated with better oral health outcomes, which in turn are linked to overall HL levels [4, 5]. In the context of empowering individuals with OHL, the information they receive in the literacy process is not limited to reading, writing, speaking, listening, and numeracy [6] of the dental lexicon, but also includes equipping individuals with knowledge to understand oral health issues and concepts, critically differentiate between fact and fiction, and develop the capacity for self-monitoring and oral self-care behavior. Various channels of literacy in oral health are currently used, with the target audience varying according to multiple factors such as socio-demographic, familial [7], ethnic, educational-cultural, linguistic, oral health knowledge, and OHL among the community. In modern evidence-based dental prevention programs to improve HL, the inclusion of digital transmission channels, teledentistry, social media platforms (YouTube, Facebook, Twitter) [8,9], and not least, generative artificial intelligence Large Language Models (LLM) platforms such as Chat Generative Pre-training Transformer (GPT), Google Gemini, Microsoft Copilot and others, have not only improved access to information and medical services but have also optimized dental prevention by making it more attractive, accessible, personalized, and interactive, especially for the teenage segment of the youth population [10].

While adolescence may be metaphorically described as a clinical trial for humanity, evidence-based reports by the WHO have called it an "index age" [11]. However, it is a vulnerable period of considerable physical and mental transformations, during which individuals often reject predetermined norms and create their own communication patterns [12]. Adolescent HL, specifically in dentistry, is an underexplored area concerning an individual's approach to oral healthy lifestyles and practices. Thus, existing test-based validated OHL tools were originally designed for adults. However, the strategy of differentiation for the younger group has advantages, facilitating, for example, the long-term break in the cycle of non-communicable diseases among them [13] or contributing to determining the prevalence and root causes of adolescents' misunderstanding of non-prescription, or 'over-the-counter' (OTC) medication [14].

Although the instruments that aim to evaluate OHL among adolescents are relatively scarce, each of them assesses one or more of the various dimensions of it: reading comprehension, numeracy, listening comprehension, and decision-making skills. Thus, the Test of Functional Health Literacy in Dentistry for Adolescents (ToFHLiD-A) (2007) [15] is based on reading comprehension and numeracy skills, while the Oral Health Behavior Questionnaire for Adolescents [16] is grounded on the Health Belief Model (HBM). Currently, the Rapid Estimate of Adult Literacy in Dentistry (REALD-30), developed by Lee et al. [17] is one of the most widely recognized and used tools for measuring OHL in both adults and adolescents [18]. Despite some shortcomings [19], it can be instrumental in prevention, early identification, and intervention, ultimately promoting better oral health status among adolescents [18].

Current research highlights disparities between Western and Eastern European countries, higher levels of OHL being reported in Western European countries [20]. However, there is a significant gap in understanding the level of adolescents' OHL in relationship with

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overall health, taking into account that HL levels differ among European countries in this age group [21]. Therefore, the primary objective of our study was to assess the relationship between HL and OHL degrees in a sample of adolescents from Bucharest, based on the alternative hypothesis that there is a positive correlation between them. Due to the lack of consistent scientific data within this age category in our country, the study aimed also to test possible associations between adolescents' HL levels and various individual factors, such as access to oral health-related services, or demographic factors.

MATHERIALS AND METHODS

Study Design and Sampling Procedures

A cross-sectional study was conducted in 09.10.2020 on a convenience sample of teenagers attending from a high school in Bucharest, Romania, to investigate the extent of which the level of OHL can be influenced by various key categories of predictors and its correlation with level of general HL. Thus, all adolescents (n = 63) from two classes were invited to participate anonymously in face-to-face interviews for oral and general HL assessment, followed by the completion of a written questionnaire. Initially, written consent was obtained from the school head and the teaching staff of the mentioned classes. Subsequently, parents were informed about the study and provided with a form to sign if they did not want their child to participate, two weeks prior to research. The study was conducted in accordance with the ethical principles outlined in the revised *Declaration of Human Rights* from the Helsinki Declaration, principles that are in line with the *Good Clinical Practice* guidelines and the applicable legal regulations.

Study participants

Inclusion criteria for the study encompassed the ability to read and write in the Romanian language, being within the adolescent age range, and a willingness to participate after receiving information about the study's purpose and assurances regarding the anonymity of their data. Exclusion criteria were uncorrected visual impairments. A total of 5 students did not participate: 3 were absent on the day of the interviews, and 2 were unwilling to participate). Thus, out of the initial cohort, 58 students (n = 58, aged 12-15 years) participated effectively. No incentives were used for this study.

Data Collection

Each student was invited to a separate space, where the face-to-face interview took place and the questionnaire was filled out. The first instrument tested was the Rapid Estimate of Adolescent Literacy in Medicine (REALM-Teen), developed in 2006 in English to measure HL among adolescents [22]. This tool was adapted from the Rapid Estimate of Adult Literacy in Medicine (REALM) to specifically to younger populations, recognizing that early intervention can significantly impact long-term health outcomes [23]. The tool aims to evaluate the ability of teenagers to understand and use health-related information effectively by the correct and pronunciation of 66 items, which are common medical terms that adolescents might encounter. These terms are arranged in increasing order of difficulty, and the participants are invited to read them aloud, thus allowing for a comprehensive assessment of the participant's HL level. In our study, we adopted the following simplified scoring system: a score between 0-62 points represents a low level of HL among adolescents, while a score in the range of 63-66 points indicates a high level of HL.

The other tested tool in our survey was the Rapid Estimate of Adult Literacy in Medicine revised (REALM-R), which was introduced in 2003 also in English [24]. The instrument is a revised version of the original REALM and was designed to quickly identify adults at risk for poor HL. Our study allocated two scoring

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levels: adolescents obtaining 0-6 points were considered to have a low level of HL, while those scoring 7-8 points were considered to have a high level of HL. For this purpose, the students were invited to read aloud the series of 11 terms, and their pronunciation of these items was assessed for correctness.

To date, the REALM-Teen and REALM-R tools are constructed in English and have not been translated into Romanian, nor have they undergone validation for use within the Romanian-speaking population. Consequently, two Romanian dentists, fluent in English, translated the English versions of the REALM-Teen and REALM-R into Romanian. A native English speaker who had lived in Romania for ten years, then back-translated the REALM-teen and REALM-R into English. This initial Romanian version was reviewed and agreed upon by two dentists, one sociologist (all native Romanian speakers), and the native English speaker. The two versions were tested among 20 adolescents who were asked to make assessments on the clarity and difficulty of understanding the items. This did not lead to the need for any changes.

The last literacy tool we investigated on correct pronunciation was the Romanian version of the REALD-30 initially developed in 2007 in English [17], which consists of 30 items with progressive difficulty. The Romanian version of the REALD-30 underwent a rigorous process of translation and validation, including a pilot study to ensure its reliability and validity for the Romanian-speaking population [25]. REALD-30 scores are categorized into three levels: high OHL for scores of 26 and above, moderate literacy for scores between 22 and 25, and low literacy for scores of 21 or below.

For each of the three literacy tests, two researchers (RS and AD) from the study asked the subjects to read the word list aloud, so the overall score was calculated as the sum of all correctly pronounced words, with each correctly pronounced word scoring one point. In order to verify the correlation between literacy levels in both general and oral health with a cultural determinant such as the adolescents experience with specific items in their daily lives, students were asked to provide a written score for the frequency of encountering each item in their routine. The frequency test used a Likert scale where respondents rate how often they hear the pronounced word in their daily routine, with options ranging from ‘very often’ (5 points), ‘often’ (4 points), ‘rarely’ (3 points), ‘very rarely’ (2 points), to ‘never’ (1 point).

At the end, the students were provided with a written questionnaire designed to investigate various demographic factors, personal beliefs on their oral health status, as well as behaviors related to dental attendance. The first two questions focused on individual self-assessment of health status, using an item from the National Health and Nutrition Examination Survey [26] translated into Romanian: How would you describe the condition of your general health / of your mouth and teeth, using a five-point Likert-type response scale: very good (5 points), good (4 points), satisfactory (3 points), poor (2 points), very poor (1 point). The third question focused on students’ access to oral health services, specifically the utilization of dental care services, through the question: ‘Have you visited a dentist in the past year?’ with three response options: 1) Yes, once; 2) Yes, multiple times; 3) No, I have not visited a dentist in the past year. Additionally, within the category of access to oral health services, the primary reason for dental visits was investigated through the fifth question, with response options: 1) Pain; 2) Routine check-up; 3) Professional teeth cleaning; 4) Other reasons. Thus, the last question assessed the resources and the frequency of using them for getting information related to oral health (teeth and gums). At the end of the questionnaire, each student was invited to add

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their demographic information, specifically their age and gender, to their responses.

Data Analysis

The data were analyzed using IBM SPSS Statistics 25 and illustrated with Microsoft Office Excel/Word 2021. Quantitative variables were tested for normal distribution using the Shapiro-Wilk Test and were written as averages with standard deviations or medians with interquartile ranges. Quantitative independent variables with non-parametric distribution were tested between groups using Mann-Whitney U/Kruskal-Wallis H tests. A p-value less than 0.05 were considered statistically significant.

Correlations between quantitative independent variables with non-parametric distribution were measured using the Spearman's rho correlation coefficient. Qualitative variables were written as counts or percentages and differences between groups were tested using Fisher's Exact test. Z-tests with Bonferroni corrections were used to further detail the results obtained in the contingency tables. The measure of consistency between REALM-Teen and REALM-R level scores was quantified using Cohen's kappa value.

RESULTS AND DISCUSSIONS

Descriptive variables of the study are presented in Table 1. Thus, the convenience sample consisted of 58 subjects (mean age 13.72 ± 0.98; 41 females). Regarding the HL within the studied group, most of the participants showed a high REALM-Teen level (62.1%) with 62.64 ± 2.62 mean score, as also a high REALM-R level (91.4%), with a mean 7.5 ± 0.7. The OHL within the investigated adolescents exhibited other result, respectively less than a half of the participants achieved a high REALD-30 level (41.4%) and the mean score was 24.97 ± 3.13. According to the descriptive statistics, none of the tested associations between the frequency of usage in daily conversation and the existence of correct spelling were significant for the items in all three health literacy tools.

The investigation of rated personal health of the subjects revealed that most of the participants had a good (55.2%) or very good (36.2%) overall health self-perception, as well as a good (55.2%) or very good (31%). Concerning access to oral health services, a half of the teenagers (50%) of the participants had multiple dentist visits in the last year, 34.5% had only one dentist visit and 15.5% had none (of those participants, 77.8% had their last dentist visit about 2-3 years ago). Most of the participants considered they would visit a dentist for pain problems (41.4%) or routine check-ups (43.1%), the results are similar for the reasons of their last dentist visit: 34.5% of them were for pain problems and 41.4% for routine check-ups.

Considering environmental factors, such as the sources of information for oral health, the adolescents answered that the most frequent sources are: contacting the dentist (often – 34.5% and very often – 15.5%), and the internet being ranked on the second place (often – 25.9% and very often – 19%).

Table 1. Descriptive characteristics of the participants.

Parameter	Value
Gender (N, %)	41 (70.7%) Female, 17 (29.3%) Male
Age (Mean±SD, Median (IQR))	13.72 ± 0.98, 14 (13-15)
REALM-Teen score (Mean±SD, Median (IQR))	62.64 ± 2.62, 63 (61.75-65)
REALM-Teen level (N, %)	22 (37.9%) Low, 36 (62.1%) High

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REALM-R score (Mean±SD, Median (IQR))	7.5 ± 0.7, 8 (7-8)
REALM-R level (N, %)	5 (8.6%) Low, 53 (91.4%) High
REALD-30 score (Mean±SD, Median (IQR))	24.97 ± 3.13, 24.5 (23-27)
REALD level (N, %)	7 (12.1%) Low, 24 (41.4%) Average 27 (46.6%) High
Self-assessed general health status (N, %)	0 (0%) Very poor,1 (1.7%) Poor, 4 (6.9%) Average 32 (55.2%) Good, 21 (36.2%) Very good
Self-assessed oral health status (N, %)	0 (0%) Very poor,1 (1.7%) Poor, 7 (12.1%) Average 32 (55.2%) Good, 18 (31%) Very good
Last year dentist visit frequency (N, %)	9 (15.5%) Absent, 20 (34.5%) One visit, 29 (50%) Multiple visits
Reason for dentist visit (N, %)	24 (41.4%) Pain, 25 (43.1%) Routine check-up 4 (6.9%) Dental hygiene, 5 (8.6%) Orthodontic check-up

	Source of information for oral health (N, %)				
Source usage	Never	Very rarely	Rarely	Often	Very often
Dentist	3 (5.2%)	6 (10.3%)	20 (34.5%)	20(34.5%)	9 (15.5%)
General practitioner	18 (31%)	14 (24.1%)	8 (13.8%)	9 (15.5%)	9 (15.5%)
Pharmacist	20 (34.5%)	19 (32.8%)	8 (13.8%)	6 (10.3%)	5 (8.6%)
Internet	9 (15.5%)	11 (19%)	12 (20.7%)	15(25.9%)	11 (19%)
TV	27 (46.6%)	15 (25.9%)	10 (17.2%)	5 (8.6%)	1 (1.7%)
Radio	45 (77.6%)	8 (13.8%)	4 (6.9%)	1 (1.7%)	0 (0%)
Magazines	28 (48.3%)	17 (29.3%)	7 (12.1%)	6 (10.3%)	0 (0%)
Friends/relatives	8 (13.8%)	13 (22.4%)	15(25.9%)	19(32.8)	3 (5.2%)

The hypothesis of the study focusing on the relationship between oral and general HL among studied adolescents was confirmed by non-parametric correlational analysis, focusing on the relationships between REALM-Teen, REALM-R and REALD-30 scores. Thus, although the correlation between the REALM-Teen and REALM-R scores was not significant ($p = 0.178$), those between the REALM-Teen and REALD-30 ($p < 0.001$, $R = 0.545$) and between REALM_R and REALD-30 ($p = 0.046$, $R = 0.263$) were positive and significant (Table 2).

Table 2. Correlations between REALM-Teen, REALM-R and REALD-30 scores.

Correlation	p*
REALM-Teen ($p < 0.001$**) x REALM_R ($p < 0.001$**)	0.178, R = 0.179
REALM-Teen ($p < 0.001$**) x REALD ($p = 0.047$**)	*<0.001*, R = 0.545
REALM-R ($p < 0.001$**) x REALD ($p = 0.047$**)	*0.046*, R = 0.263

*Spearman's rho Correlation Coefficient, **Shapiro-Wilk Test.

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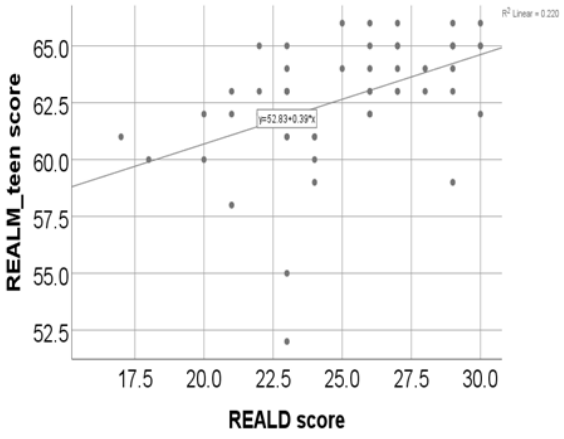
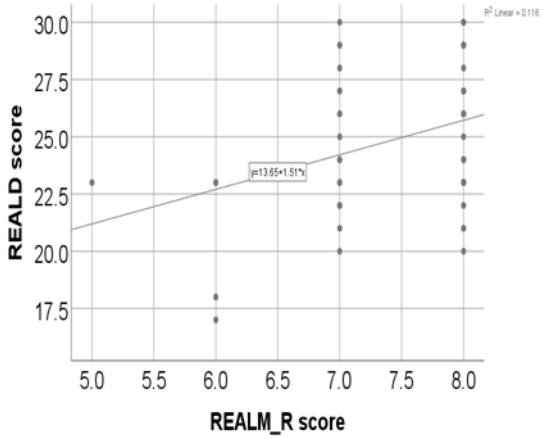
There was a positive and significant correlation of medium (Fig. 1a) and low power (Fig. 1b), showing that subjects with a high REALM-Teen or REALM-R score were significantly more associated with a high REALD-30 score and vice versa.



(a)



(b)

Figure 1. Correlation between REALM-Teen and REALD-30 scores (a) and REALM-R and REALD-30 scores (b).

The same interdependence was obtained by evaluating the associations between the REALM-Teen, REALM-R, and REALD-30 levels, the Z-tests with Bonferroni correction exhibiting significant association between REALM-Teen and REALD-30 levels (p = 0.002) (Table 3) and also a significant one between REALM-R and REALD-30 levels (p = 0.029) (Fig. 2a, b). Z-tests with Bonferroni correction showed that that participants with a low REALD-30 level were significantly more associated with a low REALM-R level (40% vs. 9.4%), while participants with a high REALD-30 level were significantly more associated with a high REALM-Teen level (63.9% vs. 18.2%).

Table 3. Distribution of the participants according to the REALM-Teen, REALM-R and REALD-30 levels.

REALM-Teen /REALM-R	**Low**		**High**		**p***
	Nr.	**%**	**Nr.**	**%**	
Low	4	80%	18	34%	0.063
High	1	20%	35	66%	k = 0.181
REALM-Teen / READLD	Low		High		p*
	Nr.	%	Nr.	%	

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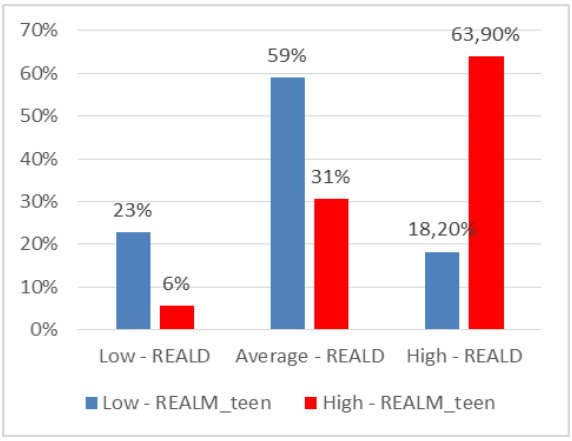
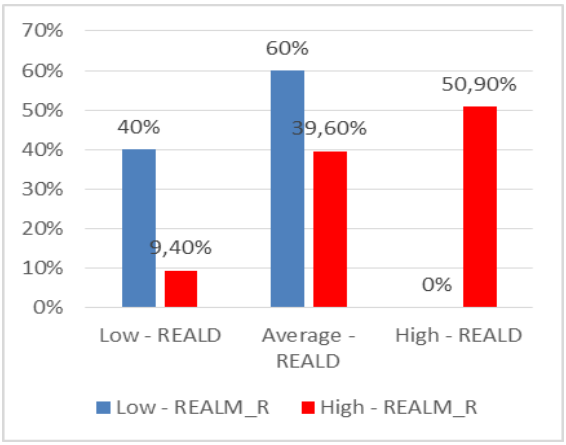
Low	5	22.7%	2	5.6%	
Average	13	59.1%	11	30.6%	0.002
High	4	18.2%	23	63.9%	

REALM-R / READ	Low		High		p*
	Nr.	%	Nr.	%	
Low	2	40%	5	9.4%	
Average	3	60%	21	39.6%	0.029
High	0	0%	27	50.9%	



(a)



(b)

Figure 2. Distribution of the participants according to REALM-Teen and READ levels (a), and to REALM-R and READ-30 levels (b).

Data from Table 4 show that the differences between groups were not statistically significant according to the Fisher tests ($p > 0.05$) as such none of the score levels were significantly associated with a particular gender.

Table 4. Distribution of the participants according to the REALM-Teen, REALM-R, READ-30 levels and gender.

REALM-Teen / Gender	**Female**		**Male**		**p***
	N	**%**	**N**	**%**	
Low	17	41.5%	5	29.4%	0.554
High	24	58.5%	12	70.6%	

REALM-R /	Female		Male		p*

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Gender	N	%	N	%	
Low	3	7.3%	2	11.8%	0.624
High	38	92.7%	15	88.2%	
READ-30 /	Female		Male		p*
Gender	N	%	N	%	
Low	4	9.8%	3	17.6%	
Average	18	43.9%	6	35.3%	0.612
High	19	46.3%	8	47.1%	

However, there was an association related to their age. Specifically, higher REALM-Teen levels (p = 0.025) were significantly associated with younger teenagers (median age = 13, IQR = 13-14.75) compared to participants with lower REALM-Teen levels (median age = 14, IQR = 13-15) (Table 5).

Table 5. Comparison of age according to the REALM-Teen, REALM-R, REALD-30 levels.

Age/REALM-Teen	**Average ± SD**	**Median (IQR)**	**Mean Rank**	**p***
Low (p = 0.001**)	14.09 ± 0.81	14 (13-15)	35.55	0.025
High (p < 0.001**)	13.5 ± 1.02	13 (13-14.75)	25.81	
Age/REALM-R	Average ± SD	Median (IQR)	Mean Rank	p*
Low (p < 0.001**)	13.8 ± 0.44	14 (13.5-14)	31.40	0.809
High (p < 0.001**)	13.72 ± 1.02	13 (13-15)	29.32	
Age/READ-30	Average ± SD	Median (IQR)	Mean Rank	p***
Low (p = 0.086**)	13.71 ± 0.75	14 (13-14)	29.43	
Average(p = 0.002**)	13.92 ± 1.01	14 (13-15)	32.71	0.405
High (p < 0.001**)	13.56 ± 1.01	13 (13-15)	26.67	

Regarding the relation between self-rated overall and oral health of the teenagers and the all three HL tools levels investigated by Fisher tests, none of the levels were significantly associated with a particular self-perceived health status (p > 0.05).

Also, the association between the access to oral health services, such as last year's dentist visits frequency and reason to dental office appointment and the literacy levels did not reach the threshold of statistical significance according to the Fisher tests (p > 0.05). Moreover, although a significant proportion of adolescents (41.4%) were driven by pain to their last dentist visit, the REALM-Teen, REALM-R, and REALD-30 score levels and the reason for the last dental visit revealed no statistically significant correlation, according to the Fisher tests (p > 0.05).

Data from Table 6 show the distribution of the participants according to the REALM-Teen, REALM-R, REALD-30 levels and sources of information for oral health. Differences between groups were not statistically significant according to the Fisher tests (p > 0.05) as such none of the score levels were significantly associated with a particular source of information for oral health, an exception being the association between REALD-30 level score and the usage of Internet as a source of information (p = 0.011) where Z-tests with Bonferroni correction showed that participants with an average REALD-30 score responded more frequently that they would either use the Internet very rarely or very often rather than rarely as a source of information for oral health (63.6% / 54.5% vs. 0%).

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Table 6. Distribution of the participants according to the OHL and HL levels and sources of information for oral health.

READLD-30 / Source-Dentist	**Never**		**Very rarely**		**Rarely**		**Often**		**Very often**		**p***
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	
Low	1	33.3%	1	16.7%	2	10%	2	10%	1	11.1%	
Average	1	33.3%	2	33.3%	8	40%	9	45%	4	44.4%	0.980
High	1	33.3%	3	50%	10	50%	9	45%	4	44.4%	
REALM-Teen / Source-G.P.	Never		Very rarely		Rarely		Often		Very often		p*
	N	%	N	%	N	%	N	%	N	%	
Low	9	50%	4	28.6%	4	50%	2	22.2%	3	33.3%	0.567
High	9	50%	10	71.4%	4	50%	7	77.8%	6	66.7%	
REALM-R / Source- G.P.	Never		Very rarely		Rarely		Often		Very often		p*
	N	%	N	%	N	%	N	%	N	%	
Low	2	11.1%	1	7.1%	1	12.5%	0	0%	1	11.1%	0.926
High	16	88.9%	13	92.9%	7	87.5%	9	100%	8	88.9%	
REALM-Teen / Source-Internet	Never		Very rarely		Rarely		Often		Very often		p*
	N	%	N	%	N	%	N	%	N	%	
Low	4	44.4%	5	45.5%	4	33.3%	6	40%	3	27.3%	0.916
High	5	55.6%	6	54.5%	8	66.7%	9	60%	8	72.7%	
REALM-R / Source- Internet	Never		Very rarely		Rarely		Often		Very often		p*
	N	%	N	%	N	%	N	%	N	%	
Low	1	11.1%	1	9.1%	1	8.3%	0	0%	2	18.2%	0.543
High	8	88.9%	10	90.9%	11	91.7%	15	100%	9	81.8%	
READLD-30 / Source- Internet	Never		Very rarely		Rarely		Often		Very often		p*
	N	%	N	%	N	%	N	%	N	%	
Low	1	11.1%	2	18.2%	3	25%	0	0%	1	9.1%	
Average	4	44.4%	7	63.6%	0	0%	7	46.7%	6	54.5%	0.011
High	4	44.4%	2	18.2%	9	75%	8	53.3%	4	36.4%	

*Fisher's Exact Test.

Discussions

Preventive dentistry plays a crucial role in addressing oral diseases, which continue to represent a significant public health challenge worldwide, particularly in underprivileged developed nations and developing countries where access to dental care and education remains limited [27]. This challenge is underscored by the severe pain, functional impairment, and diminished quality of life commonly associated with various oral disorders [28]. OHL remains a critical factor influencing oral health outcomes by directly affecting individuals' comprehension of dental instructions and health information, which in turn adversely impacts their ability to manage their oral health effectively. Research indicates that higher levels of OHL are linked to improved quality of life, as individuals who understand their oral health conditions are better equipped to make informed decisions regarding their care [29]. This relationship is particularly significant among vulnerable populations, where socioeconomic and demographic factors further complicate the dynamics of HL and overall quality of life [26]. Studies have shown that low OHL can lead to missed dental appointments [30], exacerbating communication barriers between patients and specialists. Consequently, an individual's ability to obtain, interpret, and effectively communicate medical information is crucial, as it directly influences their oral health-related decisions. These decisions

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encompass a range of factors, including access to health services, adherence to treatment regimens, knowledge levels regarding oral health, engagement in healthy or risky behaviors, and attitudes towards preventive care.

Further implications of low OHL extend beyond individual decision-making, creating a detrimental domino effect that ultimately results in a decline in oral health status. This trajectory is characterized by an increased risk of periodontal disease [31], suboptimal oral hygiene practices [32], a higher prevalence of dental caries [33], an increased number of missing teeth [34], and even a greater incidence of bruxism [35]. Each of these factors contributes to a cycle of poor oral health outcomes that can be challenging to reverse, highlighting the urgent need for targeted interventions aimed at improving OHL within vulnerable populations, particularly adolescents. While the levels of OHL in Romania have been examined, specific and detailed statistics regarding the adolescent target group remain a challenging area of research and are particularly scarce, as illustrated by Table 7.

Table 7. Romanian studies on OHL.

Study	OHL tools	Study aim	Location	Sample size	Age	Scope
Sfeatcu et al. (2021) [25]	REALD-30	Validation of the Romanian REALD-30	Bucharest	224	18-51	Word recognition
Sfeatcu et al. (2015) [36]	REALM -Teen, REALM-R, REALD-30	To assess the level of HL in relation to pattern of addressing the doctors.	Bucharest	95	15-16	Word recognition
Sfeatcu et al. (2016) [37]	REALD 30	To evaluate the relationship between level of knowledge in dentistry, behaviour regarding visiting the dentist and OHL	Bucharest	150	16-Nov	Word recognition
Cosma A.M. et al. (2019) [38]	Chew´s three screening questions	To assess the level of oral health and HL	Bucharest and Warsaw	122	19-59	Screening for limited HL skills
Coman et al. (2022) [39]	HLS-EU-Q16	Validation and assessment of HL predictors	North-West Romania	1.622	≥ 18	Competencies (find, understand, appraise and apply health information)
Sfeatcu et al. (2022) [40]	Chew's three screening questions	To assess the attitudes, the values, the behaviours and the literacy related to oral health and to dental professional services	All regions of Romania	600	18-74	Screening for limited HL skills

The primary aim of the current research was to test the hypothesis of positive correlation between the levels of HL and OHL among Romanian teenagers. We identified high levels of HL among the adolescent participants, with a mean REALM-Teen score of 62.64 and a mean REALM-R score of 7.5, both reflecting a robust understanding of health-related materials within this group. These favorable results are supported by

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previous data obtained in Romania nearly a decade ago [36], where the mean REALM-Teen score was 62.72 and the mean REALM-R score was 7.03 among the adolescent population studied at that time. The findings contribute to a comprehensive understanding of HL levels among adolescents in Romania, noting that both studies were based on similar sampling and methodology. Variations in HL scores often arise due to differences in demographics, educational interventions, socio-economic backgrounds, and the availability of community health resources, highlighting the importance of context in interpreting HL data. An example is illustrated by the divergent mean REALM-R score of only 57 reported by Dharmapuri et al. [41] in an urban cohort of chronically ill adolescents at a nonprofit children's hospital in Washington, DC. However, the health status of the investigated group does not appear to be a reliable predictor of HL among adolescents, as shown in the study by Chisolm et al. [42], which found that 52% of chronically ill teens from a pediatric Medicaid ACO exhibited adequate HL, as measured by the REALM-Teen tool.

In terms of the level of OHL among adolescents, this area remains globally underexplored and has received insufficient attention regarding its implications. To the best of our knowledge, it has not been adequately investigated in relation to general HL levels, resulting in a substantial gap in understanding the specific nuances and consequences of OHL within this demographic. One of the few studies in this area dates back to 2015 and reported a positive correlation, albeit not strong, between the REALM-66 and REALD-30 in university students in India [43]. Also in 2015, alongside the HL determinants assessed through the REALM-Teen and REALM-R, OHL was evaluated using the REALD-30 by Sfeatcu et al. [36], though no associations between variables were tested at that time. In the absence of statistical significance, the key observation from this research was that the adolescent cohort demonstrated high scores on the HL tools (REALM-Teen and REALM-R), along with primarily moderate to high scores in OHL, as measured by the REALD-30.

In the current study, the hypothesis was confirmed, indicating a strong association between general HL and OHL in the adolescents. Thus, correlations between the REALM-Teen and REALD-30 one the one hand, and on the other between REALM_R and REALD-30 were positive and significant, although the correlation between the REALM-Teen and REALM_R scores was surprisingly, not significant. This lack of association could indicate that the REALM-R may capture broader, more generalized HL skills, while REALM-Teen is tailored to reflect literacy in health areas more relevant to adolescents. This variation might affect their REALM-Teen scores more significantly than REALM-R, resulting in score differences.

While direct studies specifically linking the frequency of usage and correct spelling of health terms to HL and OHL in adolescents are limited, existing literature suggests a positive correlation [44]. Engaging with health terminology in daily conversation and demonstrating proficiency in spelling may serve as predictors of both health and oral health literacy, ultimately influencing health outcomes [45]. For instance, Khan et al. [46] highlighted that while word recognition tests, such as the REALD-30, can assess familiarity with dental terms, they do not necessarily capture comprehension or practical application of that knowledge in real-life contexts [47]. It suggests that regular exposure to health terminology may enhance understanding and retention, thereby improving HL. Despite expectations, our study revealed that none of the tested associations between the frequency of usage in daily

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conversation and the existence of correct spelling were significant for the items in all three HL tools. This lack of significant correlation raises several important considerations. First, the absence of significant associations suggests that merely using health-related terminology in daily conversation does not necessarily translate to improved HL or OHL among adolescents. This finding aligns with the notion that HL is a multifaceted construct that encompasses not only familiarity with terminology but also comprehension and the ability to apply that knowledge in practical contexts [48]. The tools used in this study, while valuable for assessing certain aspects of literacy, may not fully capture the complexities of HL as it relates to everyday communication and understanding. Otherwise, in light of the absence of significant correlations between the frequency of usage in daily conversation and the items of the three tools (REALM-Teen, REALM-R, and REALD-30) among adolescents, it is imperative to identify alternative predictors that may influence the level of HL in this demographic. This finding suggests that the factors contributing to HL within the adolescents are more complex than previously anticipated and may extend beyond mere exposure to health-related terminology in everyday discussions.

The study also aimed to test specific predictors for OHL as well as HL among adolescents. Regarding the category of demographic variables, none of the score levels of the REALM-Teen, REALM-R, and REALD-30 were significantly associated with a particular gender. These findings suggest that gender does not play a significant role in determining the levels of HL or OHL among adolescents. This contrasts with some existing literature that indicates gender differences in HL outcomes. For instance, studies have shown that females often exhibit higher HL levels compared to males [40,49-51], potentially due to greater engagement in health-related discussions and activities. However, considering that the aforementioned research focused on the adult population, our findings reveal that this trend may not apply to adolescents, indicating that other factors may play a more significant role in shaping HL within this demographic.

Previous research on different adult population groups indicates that age and developmental factors can significantly influence HL outcomes. Thus, as individuals age, they may face more complex health-related decisions and behaviors, which can complicate their understanding of health information [52]. This suggests that while older adolescents may have broader health experiences, younger adolescents might benefit from a more focused approach to learning about oral health, resulting in better outcomes in OHL. For instance, Haridas et al. [53] observed a negative correlation between age and REALD-30 scores, suggesting that younger individuals tend to exhibit better OHL skills. This finding aligns with the results of our study, which revealed that higher REALM-Teen scores were significantly associated with younger adolescents compared to those with lower REALM-Teen scores, suggesting that younger individuals tend to exhibit better HL skills. Although the inverse proportional relationship is confirmed, our study is fundamentally distinguished by the fact that the HL measurement tool for which these associations were detected was specifically designed for teenagers. Additionally, although the ages investigated by us did not differ significantly (13-15 years), an explanation for this trend could be that younger adolescents are often more engaged with educational resources and health information, which enhances their understanding and application of health-related knowledge [54].

Regarding the relationship between self-

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perceived overall and oral health of the teenagers and the HL tools levels investigated by us, none of the levels were significantly associated with a particular self-perceived health status. The absence of these correlations could be explained from the perspective of personal self-efficacy among adolescents [55], which, alongside other determinants such as social support and the school environment, may significantly influence their HL levels [54]. Also, these factors can significantly impact how adolescents perceive their health and their ability to engage in health-promoting behaviours. The absence of significant associations in our findings may reflect the influence of these external factors, which can overshadow the direct effects of HL.

The next finding that access to oral health services, such as the frequency of dental visits and the reasons for dental appointments, was not correlated with overall health and OHL in adolescents can be argued through several theoretical frameworks and empirical studies. One possible explanation for this lack of correlation is the concept of utilization of dental services [56], which is influenced by various factors beyond HL and self-perceived health [57]. As an illustration, Nazir's study on patterns of dental visits among adolescents [58] indicated that factors such as self-esteem, embarrassment due to poor oral health, and the presence of dental pain—the latter being the main reason confirmed by our respondents for visits to the dentist—can significantly influence whether adolescents seek dental care. This suggests that even if adolescents possess high HL, their motivations for visiting the dentist may be more closely tied to immediate health concerns rather than their overall health perception or literacy levels. In understanding these findings, it is essential to consider the multifaceted nature of health behaviors. Access to dental services is influenced by a combination of personal beliefs, social factors, and systemic barriers [59]. Therefore, while HL is undoubtedly important, it may not be the sole determinant of dental service utilization among adolescents.

Our research shows that HL among the adolescents studied, as indicated by the REALM-Teen and REALM-R levels, is not influenced by a particular source of information for oral health, while OHL may be associated with internet usage. The finding presents an interesting perspective on the complexities of HL in this demographic. Thus, the association between OHL and internet usage suggests that adolescents may turn to online resources for specific health information, particularly regarding oral health. This is consistent with the findings of Guo et al. [54], who highlighted the challenges adolescents face when using the internet to access health information, indicating that while the internet can be a valuable resource, it also presents difficulties in discerning credible information). The internet's role as a source of health information is increasingly significant, as many adolescents are digital natives and may prefer online resources for their accessibility and immediacy. On the other hand, the traditional sources of health information, such as healthcare providers or educational institutions, may not adequately address oral health topics, leading adolescents to seek information online. Martinović et al. [60] emphasized the need for training in effective health information searches and evaluating the quality of information found online, indicating that adolescents may lack guidance in accessing reliable oral health information through traditional channels. Additionally, the limitations of traditional information sources and the influence of peer networks further emphasize the internet's role as a primary source of oral health information.

At the end, some potential limitations of our study need to be highlighted, such as the sample size and generalizability. This research

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was monocentric, conducted in a single high school in Bucharest, Romania, using a reduced and localized convenience sample of 63 teenagers. Consequently, the findings are particularly relevant to this distinct urban area and may not be generalizable to other adolescent populations in Romania or different cultural and socio-economic contexts. The cross-sectional design of the study provides single point-in-time analysis, which limits the ability to infer causality or observe changes over time. To comprehensively understand the evolution of HL and OHL during adolescence, longitudinal studies are therefore required.

Another limitation arises from the design of the tools we used to evaluate OHL and HL levels. Currently, the tools being used for both HL and OHL measurements, are primarily based on the pronunciation and comprehension of isolated words, focusing on reading and understanding, writing, and numeracy skills [61]. Although instruments such as the REALM-Teen, REALM-R, and REALD-30 are validated, they primarily assess the recognition and pronunciation of health-related terms rather than evaluating comprehension or the practical application of health information. As a result, they may not fully capture the complexities of HL and OHL in adolescents. Also, the adaptation of the REALM-Teen and REALM-R for a Romanian context might not fully account for cultural nuances in HL and the translation and adaptation process could have been affected the reliability and validity of the tools.

Further, the study did not control for potential confounding variables such as socio-economic status, parental education, which could have influenced HL and OHL levels. Since the sample was drawn from a single high school, there might have been selection bias, as the participants who agreed to take part in the study could have different characteristics compared to those who did not participate, to adolescents in rural regions etc.

The predictors for OHL in adults did not similarly apply to adolescents. Specifically, factors such as the frequency of usage in daily conversation and the presence of correct spelling were not significant across all three HL tools. In terms of demographic variables, none of the score levels from the REALM-Teen, REALM-R, and REALD-30 tools showed a significant association with gender among the participants. An exception was found in the significant association between high levels of HL, as measured by the adolescent-specific tool (REALM-Teen), and the younger adolescents within the study group. Furthermore, individual and behavioral predictors in adults, such as self-perceived overall and oral health, as well as access to oral health services, did not correlate with overall HL and OHL in adolescents. Among the environmental factors, including health education and the quality of available health resources, only the use of digital information showed a strong relationship with oral health information among adolescents.

Summarizing, a critical future research priority should be the development of an adolescent-specific version of the REALD tool. This customized assessment instrument could yield more accurate data regarding the OHL levels of teenagers, providing essential insights for policy-making and the design of targeted interventions. Adolescents possess distinct cognitive and reading skills compared to adults, necessitating an age-appropriate tool that reflects their developmental stage and learning needs. While existing REALD tools have proven valuable, a teen-focused version could better address the unique challenges and HL gaps encountered by this demographic. Moreover, an expanded approach to OHL should consider the role of the adolescent's support network, notably parents and educators. Parental involvement in oral health education has been shown to enhance the effectiveness of literacy efforts [62],

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promoting a more holistic understanding and uptake of preventive practices across family settings. Including teachers in these educational strategies could further strengthen the impact by reinforcing oral health messages within school environments. Collaborative efforts between dental professionals, parents, and educators are essential to building a supportive ecosystem that fosters improved OHL and equips adolescents with the knowledge and behaviors to maintain oral health throughout their lives. Future research should include large, representative samples of adolescents from diverse socioeconomic backgrounds, which could provide more generalizable findings and address existing disparities in OHL.

Adding a clinical examination component to the research could also offer a more holistic understanding of the relationship between self-reported and clinically assessed oral health status. This dual approach can help to identify any gaps or inconsistencies between perceived and actual oral health among adolescents. For instance, clinical assessments can reveal underlying oral health conditions that may not be perceived or reported by teens, thus highlighting areas for targeted education and intervention.

Future studies could also examine the use of innovative technologies, such as virtual reality or gamified learning platforms, to teach oral health concepts to adolescents. Research could assess the effectiveness of these modern approaches compared to traditional oral health educational methods, especially in terms of long-term knowledge retention and behavior change.

CONCLUSIONS

1. There is an association between OHL and HL during early adolescence.
2. Our findings highlighted that age is a significant factor, with younger adolescents showing higher HL levels, as measured by the adolescent-specific tool. However, the predictors of OHL in adolescents may differ from those in other group populations, the study highlighting the need for age-appropriate tools to assess OHL and targeted interventions to improve HL in this group.
3. The study demonstrated the interrelationship between oral health and general health in adolescents, reinforcing the need for further research and the development of policies that address the specific factors influencing OHL in this population.
4. Tailored oral health policies and strategies are essential for improving prevention and promoting long-term healthy behaviors.

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