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Association Between Oral Health Status and Oral Health Literacy Among Early Adolescents

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Abstract: ***This study investigates the relationship between oral health literacy and oral health outcomes among early adolescents aged 11 to 14. A total of 106 children were assessed through clinical examination and a 33-question knowledge-based survey. Results indicate that while children aged 13-14 demonstrated notably better knowledge (85% accuracy) compared to younger peers (49%), overall oral hygiene remained poor across both age groups. Statistical analyses revealed a consistent trend where increased knowledge did not necessarily translate into improved oral hygiene behavior. These findings underscore the importance of incorporating motivational components in educational interventions aimed at fostering lasting oral health habits in children.***

Keywords: oral health knowledge, oral health literacy, children's oral health behavior, adolescent health behavior

1. Introduction

Maintaining oral health is a key factor in supporting health-related quality of life (HRQOL) and the long-term well-being of adolescents [1]. The development of healthy habits in early childhood depends on the individual behavior of children and their parents, including regular dental check-ups, the frequency and duration of tooth brushing, dietary habits, and the use of additional oral hygiene aids [2,3].

Well-established oral health habits are an essential part of the prevention of oral diseases, as they contribute to maintaining balance in the oral environment—a crucial factor in reducing the risk of developing caries and periodontal diseases [4].

The period of early adolescence (ages 11–14) is characterized by specific changes related to the psycho-emotional, social, and cognitive development of adolescents [5]. Children's behavior during this stage is influenced not only by their individual motivation, experience, beliefs, and value system, but also by sociocultural norms and the characteristics of the healthcare system operating at the population level [6]. The health habits acquired during this age are fundamental for shaping future behaviors related to maintaining their oral health [7].

Oral diseases have a direct impact on the quality of life and social well-being of adolescents. The presence of pain, bad breath, misaligned teeth, or other types of oral pathologies is not merely a personal issue; it also influences their interactions with others—an important aspect of social integration at this age, particularly in the context of increasingly influential social media platforms [8]. In this regard, children's interest and knowledge in topics related to their oral health are directly linked to the development of healthy personal behaviors [9].

Numerous scientific studies have clearly demonstrated a significant relationship between well-established hygiene habits, good oral status, and high levels of awareness regarding oral health [10,11]. Assessing adolescents' knowledge and interest in oral health topics can greatly support to developing and implementing educational strategies aimed at preventing oral diseases [12,13].

This study holds significance in identifying the gap between knowledge and behavior in adolescent oral health, which can inform the design of age-appropriate educational programs focused not just on awareness, but also on behavioral transformation.

Aim

The aim of the present study is to assess the knowledge and interest related to oral health among children aged 11–14 years and their influence on oral health status and health-related behavior.

2. Materials and Methods

2.1 Materials

The study was conducted on 106 children aged 11–14 years. Among them, 55 children aged 11–12 years were students at the 11th Primary School, Blagoevgrad, and 51 children aged 13–14 years were students at the National High School of Mathematics and Science, Sofia. Inclusion criteria for the study were the absence of fixed orthodontic appliances, absence of systemic diseases posing a risk to oral health, and signed informed consent from a parent or legal guardian. This study was conducted in full adherence to the Declaration of Helsinki and approved by the Ethics Committee of Medical University Sofia, Bulgaria (Contract No. D-168/03.08.2023).

2.2 Methods

For the purposes of the study and comparison, the children were divided into two groups: 11–12 years old and 13–14 years old. Oral status was recorded in all children using a clinical examination method, and knowledge related to oral health was assessed through a questionnaire survey.

2.3 Clinical Method

The clinical examination of the children from Blagoevgrad was conducted in the school's dental office according to a

prearranged schedule, while the students from Sofia were examined in the medical office of their school during class hours. The assessment of oral status included recording the dental, oral hygiene, and gingival status of all fully erupted permanent teeth.

a) *Dental Status*

The assessment of dental status included the recording of carious lesions with a diagnostic threshold of codes 04 and 05 according to ICDAS II [14], the presence of restorations, and teeth extracted due to caries — using the DMF (T+t) index for all present teeth.

b) *Oral Hygiene Status*

To assess oral hygiene status, we used the Full Mouth Plaque Score (FMPS) index [15]. The presence of dental biofilm was recorded using a plaque-disclosing solution, evaluating four tooth surfaces: mesio-buccal, disto-buccal, mesio-lingual, and disto-lingual. The index was calculated by summing all surfaces with plaque accumulation and dividing by the total number of examined surfaces, indicating the relative proportion of plaque-covered surfaces for each patient.

c) *Gingival Status*

Gingival status was assessed using the Bleeding on Probing (BOP) index [16]. Using an electronic periodontal probe (PA-ON Orangedental), provoked gingival bleeding was recorded at four gingival points: mesio-buccal, disto-buccal, mesio-lingual, and disto-lingual. The probing results were automatically calculated by the software of the electronic probe, providing the relative proportion of gingival tissues exhibiting bleeding on probing.

2.4 Questionnaire Survey Method

Immediately after the clinical examination, all children were given questionnaires to assess their knowledge related to oral health. The questionnaires were completed by the children in the presence of the examiner. The questionnaire consisted of 33 multiple-choice questions, each with more than one correct answer, divided into five groups.

- *Interest and Engagement (8 questions):* Focused on the motivation, interest, and involvement of the children and their parents in matters related to oral health.;
- *Knowledge of Microorganisms (3 questions):* Covered topics such as where and how microorganisms accumulate in the oral cavity, and their significance in the development of oral diseases;
- *Knowledge of Dental Biofilm (5 questions):* Included types of dental biofilm based on localization, its formation, and its relevance to oral pathology;
- *Knowledge of Oral Hygiene Procedures (9 questions):* Addressed frequency and duration of brushing, types of toothbrushes, brushing techniques, and their role in preventing oral diseases;
- *Knowledge of Caries and Gingival Inflammation (8 questions):* Focused on the characteristics, causes, and preventive behaviors related to dental caries and gum inflammation;

The responses were evaluated as either " **accurate** " or " **inaccurate**". An answer was considered accurate only if all correct statements were selected. The inaccurate category included two cases: "**Incorrect**" when at least one wrong statement was selected, regardless of whether correct ones were also marked; "**I don't know**" – when the respondent indicated uncertainty.

The analysis of the children's knowledge included an evaluation of overall performance, calculated as the relative proportion of accurate answers for each child. In addition, performance was separately analyzed for each thematic category: interest and engagement, microorganisms, dental biofilm, oral hygiene procedures, and dental caries and gingival inflammation.

3. Statistical Methods

Statistical analyses were performed using SPSS version 19 (IBM SPSS Software Inc., Chicago, IL, USA). Results were presented as means ± standard deviation. Statistical significance was determined at a level of $p < 0.05$.

The following statistical methods were applied to ensure the objectivity of the analytical results:

- Descriptive analysis
- Independent samples *t*-test
- Pearson Chi-square test

4. Results

Clinical Characteristics of the Children's Oral Status

The children participating in the study were in the stage of late mixed or permanent dentition. The following table presents their distribution by sex and age (Table 1).

Table 1: Distribution of Children by Sex and Age

Sex / Age	Boys		Girls		Total	
	N	%	N	%	N	%
11-12 years old	27	50%	28	50%	55	100%
13-14 years old	31	61%	20	39%	51	100%
Total	58	55%	48	45%	106	100%

The table shows that the children were evenly distributed by sex and age ($p > 0.05$).

The overall caries prevalence among the children participating in the study, as well as the average number of carious lesions and restored teeth, is illustrated in Chart 1 below. Teeth extracted due to caries were recorded in a single case among the younger children and therefore are not included in the presented data ($M_{11-12} = 0.04 \pm 0.18$).

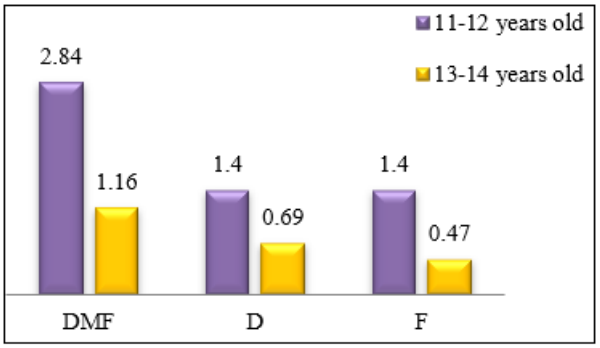

Chart 1: Caries Prevalence among the Studied Children

Among children aged 11–12 years, an average of approximately 3 teeth were affected by caries (2.84 ± 3.22), of which around 1 tooth per child had carious lesions or restorations (1.4 ± 2.06).

Among children aged 13–14 years, an average of about 1 tooth was affected by caries (1.16 ± 1.12), with fewer than one tooth per child showing carious lesions or restorations.

In the older children, the number of teeth affected by caries was twice as low ($t = 17.259$, $p < 0.05$), with a significantly lower prevalence of both carious lesions and restorations ($p < 0.05$).

The following table presents the oral hygiene and gingival status of the studied children (Table 2).

Table 2: Oral Hygiene and Gingival Status of the Studied Children

Status / Age	N	Oral hygiene FMPS	Gingival status BOP
		Mean±SD	Mean±SD
11-12 years old	55	73,56±11,011	30,84±18,321
13-14 years old	51	55,47±13,393	16,31±6,698
Total	106	64,86±15,175	23,85±15,721
Independent t test		F=16,645 p<0,05	F=20,307 p<0,05

In children aged 11–12 years, plaque accumulation affected more than 73% of the gingivally adjacent tooth surfaces (indicating poor oral hygiene status), compared to significantly lower plaque accumulation in the older children—55% ($p < 0.05$). The gingival status of the 11–12-year-old children showed bleeding on probing affecting approximately 30% of the gingival units, whereas in the older children the index values were twice as low—16% ($p < 0.05$).

Overall our results indicate poor oral hygiene status combined with early gingival inflammation in both age groups studied. Notably, both oral hygiene and gingival status improve with age.

Knowledge and Interest in Oral Health among the Studied Children

The following chart presents the overall performance of the children in the oral health knowledge questionnaire (Chart 1).

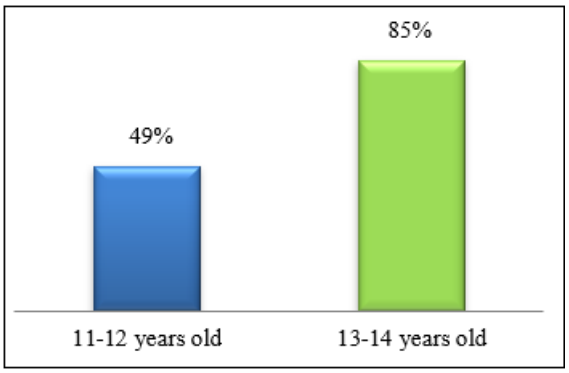

Chart 1: Overall Performance of the Studied Children by Age

The analyzed results showed that children aged 13–14 years gave almost twice as many accurate answers — 85.37 ± 16.88 — and this difference was statistically significant ($F = 13.312$, $p < 0.05$).

The following table presents the relative proportions of responses from children in the two age groups (Table 3).

Table 3: Relative Proportion of Responses by Category in the Two Age Groups

Age	Accurate		Inaccurate			
			Incorrect		I don't know	
	N	%	N	%	N	%
11-12 years old	892	49%	314	17%	622	34%
13-14 years old	1430	85%	87	5%	166	10%
Total	2312	67%	401	11%	788	22%
t test	t=26,36 p<0,05		t=11,68 p<0,05		t=18,35 p<0,05	

The table shows that children aged 11–12 years gave 49% accurate answers. Inaccurate answers among the same children accounted for just over 50%, with 17% responding "Incorrect," while the "don't know" responses were twice as many.

Children aged 13–14 years provided 85% accurate answers and 15% inaccurate answers. Among the inaccurate responses, it is noteworthy that only 5% answered " incorrect," whereas the "don't know" responses were twice as many.

Overall, the children are familiar with topics related to oral health, with the relative proportion of incorrectly learned information being relatively small. Unsurprisingly, there is a clear trend of older children demonstrating higher knowledge on oral health topics ($p < 0.05$).

The following chart presents the children's responses related to their interest in their oral health (Chart 2).

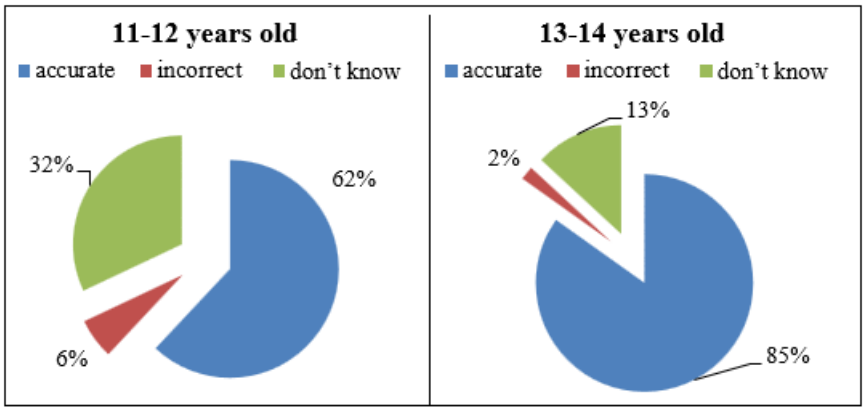

Chart 2: Children's Interest in Their Oral Health

Among children aged 11–12 years, 62% gave accurate answers. The remaining 38% showed lack of interest (6%) or indifference (32%) to the questions posed ($t = 2.55$, $p < 0.05$).

In the older children (13–14 years), over 85% gave accurate answers, indicating interest. Significantly fewer (15%) gave incorrect (2%) or "don't know" (13%) answers, reflecting a lower level of interest among this group ($t = 9.98$, $p < 0.05$).

The following table presents the knowledge of children aged 11–12 years on various topics included in the oral health questionnaire (Table 4).

Table 4: Knowledge of Children Aged 11–12 Years on Various Topics

Topics	Accurate	Inaccurate		Total
		Incorrect	I don't know	
Microorganisms	54%	12%	34%	100%
Dental biofilm	29%*	15%	56%*	100%
OH procedures	59%	13%	28%	100%
Caries and gingivitis	48%	21%*	30%	100%
t test	t*=2,80 p<0,05 p>0,05	t*=1,56 p<0,05 p>0,05	t*=2,36 p<0,05 p>0,05	

The assessment of knowledge by topics shows that children aged 11–12 years gave significantly more accurate answers on the topics of microorganisms (54%), oral hygiene procedures (59%), and caries and gingivitis (48%). This indicates that about half of the children in this age group are familiar with the basic rules and principles related to oral health. The fewest accurate answers were given on topics related to dental biofilm ($t = 2.80$, $p < 0.05$).

Significantly, the highest number of incorrect answers were given on the topics related to oral diseases—caries and gingivitis ($t = 1.56$, $p < 0.05$), while the most "don't know" responses were recorded on the topic of dental biofilm, which also showed the fewest accurate answers ($t = 2.36$, $p < 0.05$).

It can be said that children aged 11–12 years possess basic knowledge on topics related to oral health. A higher percentage of them admit to not being familiar with certain topics, while incorrectly learned information was found in about 15% of the children.

The following table presents the knowledge of children aged 13–14 years on various topics included in the oral health questionnaire (Table 5).

Table 5: Knowledge of Children Aged 13–14 Years on Various Topics

Topics	Accurate	Inaccurate		Total
		Incorrect	I don't know	
Microorganisms	90%	5%	5%	100%
Dental biofilm	85%	5%	10%	100%
OH procedures	85%	6%	9%	100%
Caries and gingivitis	87%	6%	7%	100%
t test	t= 0,31 p>0,05	t= 0,29 p>0,05	t= 0,57 p>0,05	

Among children aged 13–14 years, accurate answers across all topics ranged between 85% and 90% ($p > 0.05$). Incorrect answers were insignificantly low (around 5%–6%), without any specific topic standing out as being misinterpreted by the students. A lack of knowledge ("don't know") was shown by approximately 5%–10% of the students ($p > 0.05$).

5. Discussion

The aim of the present study was to assess the knowledge and interest related to oral health among children aged 11–14 years, as well as their influence on health behavior and oral status. We examined 58 boys and 48 girls, who were evenly distributed into two age groups: 11–12 and 13–14 years.

From our study, we found that children aged 11–12 years had significantly more teeth affected by caries compared to their older peers (DMF11-12 = 2.84). These results are related to the fact that younger children still have some primary teeth, which in most cases are either filled or have carious lesions. Due to the upcoming tooth replacement,

these teeth often remain untreated, which contributes to the higher number of carious lesions recorded in this age group.

Our results also showed an unsatisfactory oral hygiene status (FMPS = 64.86 ± 15.175) combined with early gingival inflammation (BOP = 23.85 ± 15.721) in both age groups studied. Both oral hygiene and gingival status improved with age.

Children's knowledge on topics related to oral health showed that about half of the 11-12-year-olds gave correct answers in the questionnaire, while significantly more knowledge was observed in the older children (85%). Patel studied children aged 6-12 years, assessing their oral hygiene behavior, knowledge related to the risk of developing oral diseases, and frequency of preventive check-ups. The author found, similar to our results, that with increasing age, children generally demonstrate a higher level of knowledge (17). Rani et al. conducted a detailed study of knowledge and behavior related to oral hygiene in 800 children aged 12-16 years and found significantly higher results in children over 14 years of age (18). All these data provide evidence that children acquire increasingly better knowledge as they grow older. This is a natural process in which children, over time, receive and build upon information related to oral health not only from their family environment but also from school, friends, acquaintances, and social networks. Additionally, they accumulate individual experience and change their concepts and understanding of health as a whole (19).

An interesting finding in both age groups we studied is that twice as many children responded with "I don't know" compared to "incorrect" answers when giving inaccurate responses. A cross-sectional survey among 1,027 secondary school students investigating knowledge, attitudes, and behaviors related to oral health found similar patterns (20). We consider these results encouraging because they suggest that children question and critically evaluate their own knowledge rather than having firmly memorized incorrect information. Such gaps are easier to address and change through proper education compared to correcting already ingrained misconceptions (21).

The assessment of interest in topics related to oral health aimed to determine the level of motivation, interest, and engagement of adolescents towards various aspects of their oral behavior. We found that over 62% of children aged 11-12 showed interest, while among the older group, the relative share of interest was about 85%. These results indicate a high level of involvement and motivation of the children to actively participate in maintaining their oral health. The higher engagement in the older children is likely related to the increasing social importance of oral health with age, when children begin to seek social approval, pay more attention to their appearance, and how they are perceived by their peers.

We found that children aged 11-12 gave the most correct answers on the topic of "oral hygiene procedures" (59%). Despite the high relative share of correct answers in this area, the oral hygiene status remaind unsatisfactory, sugegesting that despite their knowledge, these children do not have properly established oral hygiene habits and behavior. A similar pattern was observed among the older children; despite their even higher results, their oral hygiene status, although better compared to the younger group, remains unsatisfactory.

Based on the conducted study and obtained results, we can conclude that despite the relatively good knowledge and interest shown by children in both age groups, their oral behavior and, specifically, their oral hygiene status are unsatisfactory. This provides grounds to recommend the development and implementation of educational programs aimed not only at increasing adolescents' knowledge on oral health topics but also at including a motivational component that encourages children to adhere to learned rules and establish stable healthy habits in the long term. The development of such programs should be age-appropriate and take into account the existing knowledge to avoid repetition of already acquired information, which could lead to distraction and boredom among adolescents.

6. Conclusion

Having knowledge on topics related to oral health alone does not guarantee the formation and maintenance of proper oral behavior. Intrinsic motivation is crucial for lasting change in health habits which should become part of children's values system. Overall this will help build sustainable positive behavioral patterns that go beyond the effect of one-sided informational influence.

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