Original Article

The association between oral health literacy and oral health-related behaviours among female adolescents in the Kingdom of Saudi Arabia: A cross-sectional study

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ARTICLE INFO	ABSTRACT
	Objectives: Oral health literacy (OHL) is suggested as an important denominator of oral health. This study aimed to identify ways to improve oral health by exploring the association between oral health literacy and oral health-related behaviours among female adolescents in the Eastern Province of the Kingdom of Saudi Arabia (KSA). *Methods:* This cross-sectional study assessed OHL among 1,889 10th grade female students in the Eastern Province of the KSA. OHL was assessed using an Arabic version of the short version of the Health Literacy in Dentistry scale (A-HeLD-14). Self-reported socio-demographic information and oral health-related behaviours (toothbrushing, dental attendance, and sugary diet consumption) were also collected. The relationship between OHL and oral health-related behaviours was investigated using binary logistic regression, adjusted for socio-demographic information. *Results:* The binary logistic regression analyses showed that poor OHL was significantly associated with infrequent toothbrushing ($p < 0.001$) and irregular dental attendance ($p = 0.005$) but not with consumption of sugary diets. All A-HeLD-14 domains were significantly associated with infrequent toothbrushing, and the domains concerning access, receptivity, and financial barriers were significantly associated with irregular dental attendance. The highest odds ratios (ORs) for infrequent toothbrushing were found in the domains of receptivity (OR = 4.19) and understanding (OR = 3.85) and for irregular dental attendance in the financial barriers (OR = 1.61) and access (OR = 1.49) domains, followed by the receptivity domain (OR = 1.35). *Conclusion:* Poor OHL was significantly associated with infrequent toothbrushing and irregular dental attendance. Interventions focusing on OHL are warranted to improve oral health-related behaviours and thereby oral health in the population. The aspects that seem most vital to target are improved access to dental care, including the reduction of economic barriers, as well as increased awareness of oral health in the population.

1. Introduction

Almost half of the worldwide population suffers from oral diseases, which mainly include dental caries, gingival and periodontal diseases, oral cancer, and tooth loss (WHO, 2023). This is unfortunate as oral health is an integral part of general health, and poor oral health can dramatically interfere with an individual's ability to function in society (WHO, 2023).

In the Arab world, which includes 22 countries located in the region of Middle East and North and North-East Africa, oral diseases are considered a major public health problem and incur substantial socio-economic costs, making oral diseases an economic as well as a health burden (Aljafar et al., 2021; Bokhari & Quadri, 2020). Nevertheless, awareness is lacking regarding the importance of oral health, which is reflected in the public health policy of Arab countries (Al Suwyed et al., 2021).

Despite a general improvement in socio-economic conditions in the Kingdom of Saudi Arabia (KSA) (Siddiqui et al., 2021), the prevalence of oral diseases is higher than those of other developed and developing countries. The most prevalent oral diseases in the KSA are dental caries, gingival and periodontal diseases (Al-Ansari, 2014; AlGhamdi et al., 2020; Alshammari et al., 2021, Idrees, Azzeghaiby, Hammad, & Kujan, 2014; Ministry of Health, 2021; Qataberi et al., 2020; Shubayr et al., 2021; Siddiqui et al., 2021; Tabassum et al., 2022). These diseases are preventable if good oral health behaviours are adhered to, including daily oral hygiene care, proper dietary habits, and regular dental visits (Akinyamoju et al., 2018).

Given the impact of oral health-related behaviours on the development of oral diseases (Hagman et al., 2021), it is not surprising that oral health literacy (OHL) has been suggested to play a key role in improving oral health in populations (Baskaradoss, 2016; Baskaradoss, 2018; Rizqi and Thearmontree, 2020; Wehmeyer et al., 2014). OHL has been defined as "the degree to which individuals have the capacity to obtain, process, and understand the basic health information and services needed to make appropriate oral health decisions" (American Dental Association, 2006a; 2006b). Studies have indicated that poor OHL is a risk factor for oral diseases (Batista et al., 2018; Neves et al., 2023). In the last decade, OHL has thus received considerable attention in the dental literature (Baskaradoss, 2018) and is deemed an important concept in dental research as well as dental practice (Bennett et al., 2009; Horowitz & Kleinman, 2008; Jackson & Eckert, 2008; Jones et al., 2007). The association between poor OHL and poor oral health may be caused by non-optimal oral health-related behaviours (Brega et al., 2020; Ramos-Gomez & Tiwari, 2021). Studies have indeed found that the level of OHL influence the pattern of dental attendance in both adolescents (He et al., 2022) and adults (Baskaradoss, 2016). Further, it has been found that poor OHL can lead to failure in adhering to dental recommendations (Ramos-Gomez & Tiwari, 2021; Wigen et al., 2009; Wehmeyer et al., 2014). Thus, it is not too surprising that studies have also found an association between poor OHL and infrequent toothbrushing (Cepova et al., 2018; Khajuria et al., 2019; Noor et al., 2020; Sistani et al., 2017), mediated by limited knowledge about oral health and oral health-related behaviours (Singh et al., 2022). Another important oral health-related behaviour is consumption of sugary diets and despite growing public awareness to reduce sugar intake, children in social disparities are more inclined to report high sugar consumption (Peres et al., 2021). Previous studies that assessed the associations between OHL and sugary diet consumption have reported contradictory findings (Buja et al., 2021; Mohd-Dom et al., 2015). Despite the described suggestions of an association, more studies are needed to further explore the relationship between OHL and oral health-related behaviours (Firmino et al., 2018). Such studies would not only help to understand the associations better and add to the current evidence, but also pinpoint intervention targets for improving OHL. This could indeed help prevent oral health disparities (Ramos-Gomez & Tiwari, 2021).

A relevant target group for interventions are young females. This group is in a transitional stage from childhood to adulthood, when many of the future health behaviours are being established (Maida et al., 2015). Further, women in the KSA are regarded as the cornerstone of the family. Their role in the family is essential, and their influence extends to shaping the behaviours of their family members, particularly the children (Alghamdi et al., 2022), thereby impacting children's oral health-related behaviours. In this regards, studies have demonstrated a strong correlation between maternal OHL and the oral health status of their children (Dieng et al., 2020; Sowmya et al., 2021; Tyagi et al., 2017). Intervention programmes in this target group could thus not only improve women's oral health, but also have a significant positive impact on a children's oral health.

This study aimed to assess the association between OHL and oral health-related behaviours among female adolescents in the Eastern Province of the Kingdom of Saudi Arabia. The main hypothesis was that good OHL is associated with good oral health-related behaviours. The study can potentially aid policymakers to implement proper interventional programmes and effective dental care strategies to prevent oral diseases and improve oral health.

2. Materials and methods

2.1. Ethical statement

Prior to the data collection, the research protocol was approved by the Institutional Review Board at King Saud University Medical City in Riyadh, KSA (Approval letter reference number: 21/0309/IRB). The participants were anonymised, and their data were kept confidential. Informed consent was obtained from all parents of the participants prior to data collection.

2.2. Design, setting, and participants

Data for this cross-sectional study were collected from January 2022 to October 2022 using a questionnaire to assess the oral health and oral health-related behaviours of 10th grade female students in the Eastern Province of the KSA. The Eastern Province comprises three main governorates: the main Eastern area; Al-Ahsa; and Hafar al-Batin, which formed the clusters for this study. The main Eastern Area is the largest governorate, which has a total population of 5,148,598 (GASTAT, 2020), followed by Al-Ahsa with a total population of 1.3 million, and Hafar al-Batin with a total population of 365,000. Each governorate is divided into rural areas (village and hijrah) and urban areas (city). Stratified random sampling through the Random Choice Generator (RCG, 2021) was used to randomly select the schools. A total of 18 schools were invited to participate in the study, 9 of which were selected from the main Eastern area, 6 from Al-Ahsa, and 3 from Hafar al-Batin. From each school, all students in the 10th grade were invited to participate in the research project without any specific exclusion criteria (Fig. 1). Each student was assigned an alphanumeric code, which was used to identify the student and match the questionnaire and informed consent forms.

The determination of the study sample size relied on estimating the anticipated level of OHL within the population and the potential for identifying a significant difference between the oral health-related behaviour groups. The mean OHL was set to 46 in the groups with good behaviours, whereas it was set to 42 in the groups with poor behaviours. The high means are attributed to the generally high OHL expected in the study population. With a power of 90 % and a significance level set at 0.05, a total of 190 participants per group were deemed necessary to achieve statistically significant findings.

2.3. Questionnaire

The variables used and analysed in this study included: oral health-related behaviours (outcome variables), oral health literacy (explanatory variable), and socio-demographic information (moderator variables). The participants filled in the questionnaire electronically using the Google Forms software provided to the school principals via a link. The school principals posted the link to the students through the schools' official portals. Each participant was assigned a unique code that allowed the questionnaires to be matched with the respective informed consent forms.

2.4. Oral health-related behaviours

Oral health-related behaviours were considered the outcome variables in this study. The oral health-related behaviours reported were frequency of toothbrushing, dietary habits, and pattern of dental attendance. The questions regarding oral health-related behaviours had been used previously and were inspired by the Children's Dental Health Survey 2013 Technical Report England, Wales and Northern Ireland
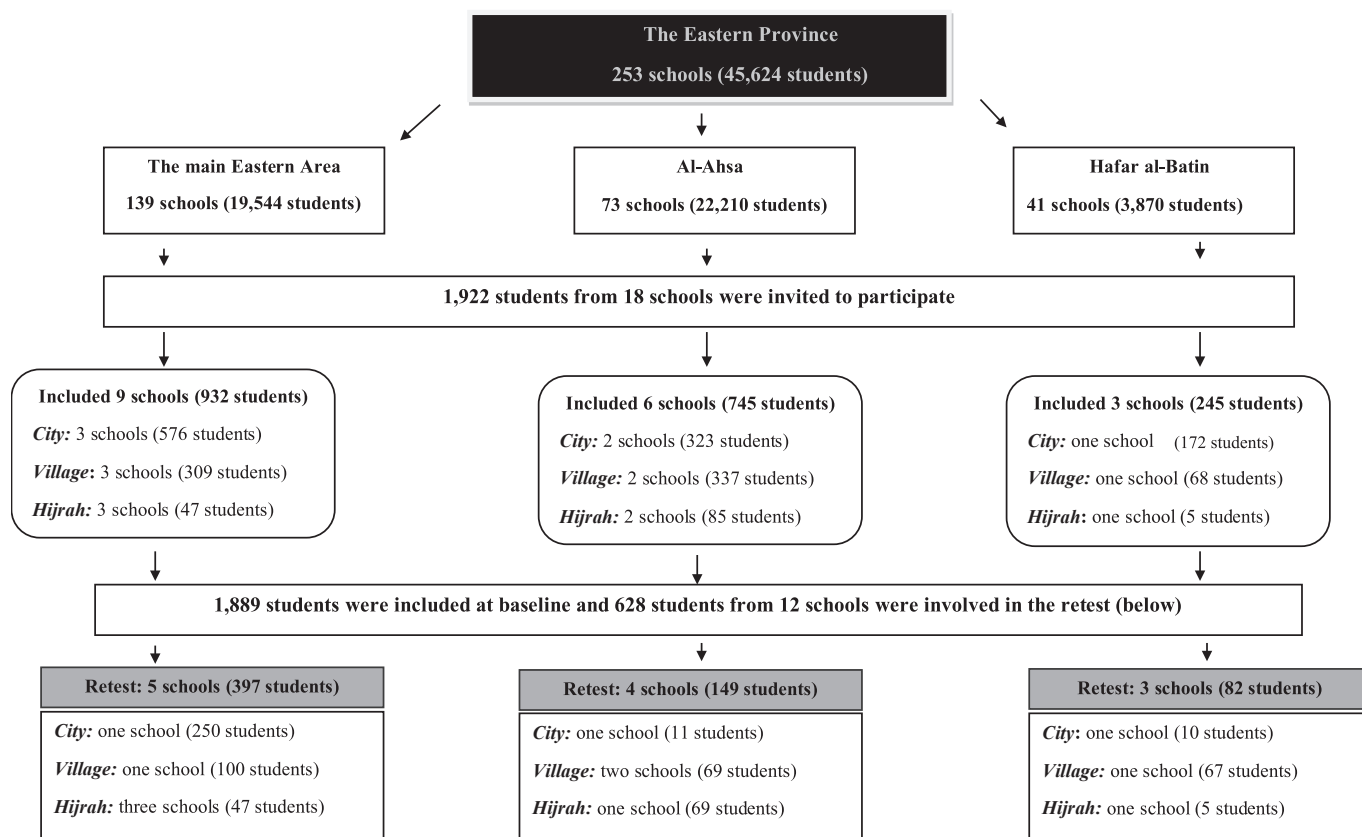
Fig. 1. The distribution of schools in clusters.

(2015) and a survey on the perceived oral health among Danes above 40 years of age (2020).

The answer categories for frequency of toothbrushing were: never, rarely, several times a month, several times a week, once a day usually in the morning, once a day usually before bed, and several times a day. The dietary habits concerned the consumption frequency of biscuits and cake, soda and energy drinks, and chocolate or other candy. The answer categories for dietary habits were: several times daily, every day, several times a week, once weekly, several times a month, and never. The answer categories for the pattern of dental attendance were: regularly, approximately once a year; regularly, approximately twice a year or even more often; when having a toothache or other acute problems; and do not visit the dentist.

For the statistical analysis, the original answer categories for the oral health-related behaviours were dichotomised. Toothbrushing was designated as frequent if performed once a day or several times a day and infrequent if performed several times a week or month, rarely, or never. Dietary habits were designated as frequent if the diet items were consumed several times daily, every day, or several times a week and infrequent if the diet items were consumed once weekly, several times a month, or never. The three selected diet items were unified into one variable with two categories (frequent and infrequent). Consumption was designated as frequent if at least one diet item was consumed frequently, and infrequent when all three diet items were consumed infrequently. Dental attendance was categorised as regular if participants visited the dentist once or more a year, and irregular if the visits were related to a toothache or other acute problem or if the participant never visited a dentist.

2.5. Oral health literacy

OHL was considered the main explanatory variable in the study and was measured using the Arabic version of the HeLD-14 questionnaire

(Alzeer et al., 2023), which represents seven conceptual domains: communication, access, receptivity, understanding, utilisation, support, and economic barriers (Ju et al., 2018). Each domain has a set of questions (items), and each item is scored on a 5-point Likert scale ranging from 0 ("unable to do") to 4 ("without any difficulty"). The total HeLD-14 score is the unweighted summation of the item scores (Jones et al., 2014), and the final score for the HeLD-14 thus ranges from 0 to 56. We initially grouped the participants using quartiles. This was afterwards transitioned into three groups with the two highest quartiles indicating good OHL, the second lowest indicating medium OHL, and the lowest indicating poor OHL. This was done to better fit the groups to the distribution of the A-HeLD-14 score in the population, which in general was high. Further, this approach was more sensitive in identifying participants with poor OHL, which is the most relevant group to target.

The original categories for the individual items were dichotomised by what was considered a problem (unable to do, very difficult, with some difficulty, little difficulty), or not a problem (no difficulty). The analysis was based on the domain level, and a domain was designated as a problem if at least one of the two items in the domain was registered as a problem.

2.6. Socio-demographic information

The socio-demographic information variables were considered the moderator variables in this study and were used to adjust the analyses of the relationship between the oral health-related behaviours and OHL. They comprised strata (city, village, hijrah), parents' level of education, and parents' occupation.

The original answer categories for father's and mother's education were: no formal schooling, primary school, lower secondary school, high school, university, postgraduate, and (specified) vocational training. The original answer categories for the father's or mother's occupation

were: not employed, employed in the public sector, employed in the private sector, and retired.

For the statistical analysis, the original answer categories for the parents' education levels and occupation were trichotomised. The parents' education was categorised into three levels based on the International Standard Classification of Education −2011- (ISCED) (Schneider, 2013): high (university and postgraduate studies); medium (high school and vocational training); and low (no schooling, primary school, lower secondary school).

Father's and mother's level of education were combined into one variable as follows: both parents have a low level of education (low); both parents have a medium level of education (medium); both parents have a high level of education (high); the father or mother has a high level of education and the mother or father has a low level of education (medium); the father or mother has a high level of education and the mother or father has a medium level of education (high); the father or mother has a medium level of education and the mother or father has a low level of education (low).

The parents' occupations were trichotomised into the following categories: not employed, employed, and retired. These were based on the father's and mother's occupation as follows: both parents are employed (employed); both parents are not employed (not employed); both parents are retired (retired); father or mother is employed and mother or father is not employed (employed); father or mother is retired and mother or father is employed (employed); father or mother is retired and mother or father is not employed (retired).

2.7. Dental anxiety

The dental anxiety (DA) variable was used as additional moderator variable to the socio-demographic information to adjust the analyses of the relationship between dental attendance and OHL. Dental anxiety was measured using the validated Arabic version of the Modified Dental Anxiety Scale (MDAS) (Bahammam & Hassan, 2014). The MDAS questionnaire comprised five questions based on a Likert scale ranging from not anxious, (indicated by a score of 1) to extremely anxious (indicated by a score of 5). The scale scores ranged from 5 to 25 (Badran, Keraa, & Farghaly, 2023). The level of DA was considered high if the score was 19 or above (Appukuttan, 2016).

2.8. Statistical analyses

IBM SPSS software version 28 was used for data analysis. A statistical significance level of 0.05 was applied.

Descriptive statistics were used to determine the frequencies and distributions of the included variables, in addition to the mean and median values for the total score of A-HeLD-14.

Binary logistic regressions were used to investigate the relationship between OHL and the three outcomes regarding oral health-related behaviours. Models were made with both OHL as levels based on the total score of A-HeLD-14 and as individual domains in separate models. For each outcome, an unadjusted model was first created with OHL as the sole explanatory variable. Next, adjusted models were created by including the socio-demographic variables in the models in addition to dental anxiety in the models that dealt with dental attendance as an outcome variable. Odds ratios and confidence intervals were extracted from all models.

3. Results

3.1. Participants

Out of the 1,922 students invited to participate in the study, 1,889 (98.3 %) students were included. The main reasons for exclusion were missing informed consent ($n = 1$), negative informed consent ($n = 1$), the student declined participation in the study ($n = 3$), the student transferred to another school during the data collection period ($n = 11$), and technically missing questionnaire ($n = 17$). Most study participants lived in the cities and had medium-educated and employed parents (Table 1).

3.2. Oral health-related behaviours

More than three-quarters of the participants frequently brushed their teeth (78.2 %) (Table 1). The majority of the participants frequently consumed sugary diets (89.4 %) and attended the dentist irregularly (70.9 %).

3.3. Oral health literacy

The mean total score of A-HeLD-14 was 45.83 and the median was 50. The levels of OHL were as follows: 0–42 (low OHL), 43–50 (medium OHL), and 51–56 (high OHL).

All domains were most frequently reported as not being a problem by the participants (Table 2). The domains most frequently reported as problems were communication (47.2 %) and receptivity (47 %), and the domain least frequently reported as a problem was understanding (33 %).

3.4. Binary logistic regressions

The binary logistic regression analyses revealed a significant association between poor OHL and infrequent toothbrushing in both the unadjusted and adjusted models (Table 3). Poor OHL was also significantly associated with irregular dental attendance in the unadjusted model, while in the adjusted model, a medium level of OHL exhibited a significant association with dental attendance (Table 3). The association was highest in regard to toothbrushing, and participants with low OHL were 6.13 times more likely to have infrequent toothbrushing than the participants with high OHL in the adjusted model.

For all A-HeLD-14 domains, the domains reported to be a problem were significantly associated with infrequent toothbrushing in both the unadjusted and adjusted models. Regarding dental attendance, all the domains showed a significant association with irregular dental attendance except communication and understanding in the unadjusted model and communication, utilisation, understanding, and support in the adjusted model.

Receptivity and understanding, followed by financial barriers and support were the domains most strongly associated with infrequent toothbrushing, with ORs of 4.19, 3.85, 3.13, 3.06 respectively, in the adjusted models. Financial barriers and access, followed by receptivity, were the domains most strongly associated with irregular dental attendance, with ORs of 1.61, 1.49, and 1.35, respectively, in the adjusted

Table 1

Distribution of participants according to oral health-related behaviours and socio-demographic information ($n = 1889$).

Variable	Categories	n (%)
Toothbrushing	Frequent	1477 (78.2)
	Infrequent	412 (21.8)
Sugary diets	Frequent	1689 (89.4)
	Infrequent	200 (10.6)
Dental attendance	Regular	550 (29.1)
	Irregular	1339 (70.9)
Place of residence (stratum)	City	1349 (71.4)
	Village	401 (21.2)
	Hijrah	139 (7.4)
Parents' level of education	Low	683 (36.2)
	Medium	934 (49.4)
	High	272 (14.4)
Parents' occupation	Not Employed	152 (8)
	Employed	1377 (72.9)
	Retired	360 (19.1)

Table 2
Distribution of participants according to oral health literacy ($n = 1889$).

Domain	Unified categories for the items of each domain	n (%)
HeLD-14 total score	Low	516 (27.3)
	Medium	477 (25.3)
	High	896 (47.4)
Communication	Problem	892 (47.2)
	No problem	997 (52.8)
Access	Problem	804 (42.6)
	No problem	1085 (57.4)
Receptivity	Problem	888 (47)
	No problem	1001 (53)
Utilisation	Problem	838 (44.4)
	No problem	1051 (55.6)
Understanding	Problem	623 (33)
	No problem	1266 (67)
Support	Problem	766 (40.6)
	No problem	1123 (59.4)
Financial barriers	Problem	835 (44.2)
	No problem	1054 (55.8)

model.

4. Discussion

The main finding of this study is that poor OHL was especially associated with infrequent toothbrushing as well as irregular dental attendance, whereas its association with sugary diet consumption was not significant. All A-HeLD-14 domains were associated with toothbrushing, but the association was stronger for problems with receptivity and understanding. The financial barriers and access domains were strongly associated with dental attendance.

The participants in this study generally showed high levels of OHL.

They had a mean A-HeLD-14 total score close to the upper boundary of the scale and most often expressed having no problems in relation to the domains. The high OHL found in our study can probably be attributed to the study population, which comprised only female high school students. This population is indeed expected to have good OHL which exceeds that of their male counterparts (Baskaradoss, 2018; Jaafar et al., 2020; Rahardjo et al., 2016; Rizqi and Thearmontree, 2020). Studies in other populations comprising mainly young and adult participants have also shown high levels of OHL (King et al., 2023; Mohd-Dom et al., 2015). Contradicting our findings, a cross-sectional study from Brazil found that only 29.4 % of the school students aged 15–19 years included in that study had high OHL. This might be attributed to the fact that the OHL was assessed using a different OHL instrument, the Brazilian version of the Rapid Estimate of Adult Literacy in Dentistry (REALD-30), which makes comparison to our study difficult (Dutra et al., 2019). The high OHL in our population elevated the value of low level of OHL, which is higher than the values used in most other studies using the HeLD-14 (King et al., 2023). However, a study in Brazilian adults based their levels on the median HeLD-14 score, which resulted in a score of $\geq$ 47 implying high OHL (Bado et al., 2020).

A systematic review from 2018 concluded that most of the included studies reported no significant association between OHL and oral health-related behaviours (Firmino et al., 2018). Specifically, a lack of association between OHL and dental attendance was reported and most of the studies also found no significant association between OHL and frequency of toothbrushing (Firmino et al., 2018). This contrasts with the present study's findings as well as the findings from other more recent studies (Badran et al., 2023; Baskaradoss, 2016; Mohd-Dom et al., 2015; Parker & Jamieson, 2010; Sukhabogi et al., 2020; Ueno et al., 2013). Moreover, the OHL measure used in almost all of the included studies was the REALD-30 and only one study used the HeLD-14, which limits the comparability. Furthermore, the vast majority of the included studies had a high risk of bias, and most of the studies had small sample sizes, which decreased the statistical power and thus the chance of reaching a statistical significance (Firmino et al., 2018).

If the domains are taken into account, the significant association

Table 3
Binary logistic regression to predict the oral health-related behaviours from the oral health literacy (the total scores of A-HeLD-14), ($n = 1889$). * Adjusted for stratum, parents' education level, and parents' occupation. ** Adjusted for stratum, parents' education level, parents' occupation, dental anxiety. The significant associations are in bold.

Independent variable	Infrequent toothbrushing				Frequent consumption of sugary diets				Irregular dental attendance			
	Unadjusted		Adjusted*		Unadjusted		Adjusted*		Unadjusted		Adjusted**	
	OR	CI	OR	CI	OR	CI	OR	CI	OR	CI	OR	CI
OHL (A-HeLD-14)												
High	Ref.	–	Ref.	–	Ref.	–	Ref.	–	Ref.	–	Ref.	–
Medium	**2.41**	**1.77 2.28**	**2.32**	**1.70 3.17**	1.11	0.77 1.60	1.1	0.76 1.60	**2**	**1.55 2.59**	**1.75**	**1.33 2.28**
Low	**6.71**	**5.08 8.86**	**6.13**	**4.61 8.15**	1	0.70 1.41	1	0.68 1.40	**1.59**	**1.25 2.02**	1.19	0.91 1.54
Communication												
No problem	Ref.	–	Ref.	–	Ref.	–	Ref.	–	Ref.	–	Ref.	–
Problem	**2.72**	**2.17 3.42**	**2.61**	**2.07 3.29**	0.94	0.70 1.27	0.92	0.69 1.24	1.04	0.85 1.27	0.88	0.72 1.09
Access												
No problem	Ref.	–	Ref.	–	Ref.	–	Ref.	–	Ref.	–	Ref.	–
Problem	**2.93**	**2.34 3.68**	**2.88**	**2.29 3.63**	0.98	0.73 1.32	0.96	0.71 1.29	**1.77**	**1.44 2.18**	**1.49**	**1.20 1.85**
Receptivity												
No problem	Ref.	–	Ref.	–	Ref.	–	Ref.	–	Ref.	–	Ref.	–
Problem	**4.44**	**3.48 5.67**	**4.19**	**3.27 5.37**	1.2	0.89 1.61	1.2	0.89 1.62	**1.63**	**1.33 1.99**	**1.35**	**1.09 1.67**
Utilisation												
No problem	Ref.	–	Ref.	–	Ref.	–	Ref.	–	Ref.	–	Ref.	–
Problem	**2.63**	**2.10 3.29**	**2.57**	**2.05 3.24**	0.91	0.68 1.22	0.89	0.66 1.19	**1.25**	**1.02 1.52**	1.08	0.87 1.34
Understanding												
No problem	Ref.	–	Ref.	–	Ref.	–	Ref.	–	Ref.	–	Ref.	–
Problem	**3.93**	**3.13 4.94**	**3.85**	**3.06 4.86**	0.95	0.70 1.30	0.94	0.69 1.28	1.18	0.96 1.47	1.03	0.83 1.30
Support												
No problem	Ref.	–	Ref.	–	Ref.	–	Ref.	–	Ref.	–	Ref.	–
Problem	**3.24**	**2.58 4.06**	**3.06**	**2.43 3.85**	1	0.74 1.35	1.03	0.76 1.39	**1.37**	**1.11 1.68**	1.2	0.97 1.50
Financial barriers												
No problem	Ref.	–	Ref.	–	Ref.	–	Ref.	–	Ref.	–	Ref.	–
Problem	**3.43**	**2.72 4.32**	**3.13**	**2.47 3.98**	1.16	0.87 1.56	1.2	0.89 1.62	**1.88**	**1.53 2.32**	**1.61**	**1.29 2.01**

between A-HeLD-14 and the included oral health-related behaviours makes sense. Similar to our study, other studies have found a significant relationship between OHL and frequency of toothbrushing (Mohd-Dom et al., 2015; Parker & Jamieson, 2010; Sukhabogi et al., 2020; Ueno et al., 2013). Compared to the association between OHL and tooth-brushing, the association between OHL and dental attendance was somewhat lower in our study. Some studies found a significant association between OHL and dental attendance (Badran et al., 2023; Bas-karadoss, 2016; Mohd-Dom et al., 2015; Parker and Jamieson, 2010; Ueno et al., 2013), whereas other studies found no significant association between OHL and dental attendance (Firmino et al., 2018; Sukha-bogi et al., 2020). The discrepancies between the results of these studies and our study could be explained by differences in study populations and OHL measures. In some studies the population in general had poor OHL and poor oral health-related behaviours, which makes it difficult to assess the association between these two factors (Sukhabogi et al., 2020). Moreover, OHL was often measured with a simple and less sensitive instrument than the HeLD-14 and did not include items on economic barriers or access (Ishikawa et al., 2008). Moreover, some of the studies had a small sample size, making it hard to find significant differences (Firmino et al., 2018).

Few studies have investigated the association between the individual HeLD-14 domains and oral health-related behaviours, making the comparison of our findings with other studies challenging. It makes sense, however, that the problems mostly associated with infrequent toothbrushing relate to receptivity and understanding. Having difficulty with or being unable to pay attention to dental health needs or to make time for the things that positively impact oral health could hamper the opportunity for frequent toothbrushing. In another study, Mialhe and colleagues (2020) identified a significant correlation between infrequent toothbrushing and problems in the understanding domain in the HeLD-29 among an adult urban population. Similarly, Sermsuti-Anuwat and Pongpanich (2019), who also used the HeLD-29 reported a significant relationship between infrequent toothbrushing and problems in the utilisation, communication, and support domains. The discrepancy from our findings might be caused by the fact that their study focused on adults with physical disabilities, where accessing dental care and receiving support could pose greater challenges for their study population compared to our study population. It also seems reasonable that our study shows that financial and access barriers are the most relevant domains regarding dental attendance. With this knowledge it is possible to develop effective interventions and systemic changes that could result in improved oral health-related behaviours and thereby better oral health and reduced disparity in the population (Horowitz & Kleinman, 2012). Other studies have also found economy and access to be a key aspect when it comes to using the dental care system (Brothwell et al., 2008; Cooray et al., 2020; Tu et al., 2023; Xu et al., 2020). Another study investigating aspects of OHL in a deprived population also found that financial barriers were the main obstacle (King et al., 2023). A study by Sermsuti-Anuwat and Pongpanich (2019) showed a significant correlation between the pattern of dental attendance and all HeLD domains except communication. Additionally, Mialhe and colleagues (2020) identified a significant association between the access domain and the most recent dental visit. These findings align with our findings.

The present study found no significant association between OHL and the intake of sugary diets. This could be because the Saudi population in general tends to consume diets that are extremely high in added sugar (Alhusseini et al., 2023), which was also found among our study population; the vast majority had frequent intake of sugary diet, making it difficult to find significant differences. A systematic review found conflicting results between the included studies concerning the association between health literacy (HL) and sugary diet intake. Of the six included studies that assessed the association between HL and sugary diet intake, four studies reported that the association was significant, while two studies found no association (Buja et al., 2021). Besides the frequent intake of sugary diets in our population, differences in outcome and

populations could explain the differences in findings. One study reporting a significant association used intake of sugary diets between meals as their outcome, which must be considered more sensitive than the more general outcome of intake of sugary diets used in our study. In addition, the study targeted university students from a faculty of health who are probably more concerned about their dietary habits than our population is (Mohd-Dom et al., 2015).

The present study has some limitations. The sample comprised only young female high school students, which limits the transferability of the results to the entire population as some studies have found that OHL and HL are higher among females than among males (Jaafar et al., 2020; Lee et al., 2015; Rahardjo et al., 2016; Sistani et al., 2013). Moreover, as the questionnaire was distributed electronically, we missed the opportunity to provide the participants direct instructions or to clarify any needed matters or unclear questions while they were filling in the questionnaire. This might have resulted in flawed answers. The categorisation of the oral health-related behaviour variables was done based on the expected behaviours in the population. The dichotomisation of the variables could, however, have led to an overestimation of frequent toothbrushing, frequent consumption of sugary diets, and regular dental visits. Toothbrushing once a day and consuming sugary diets several times a week could be considered as infrequent and not frequent and dental visits every second year as irregular instead of regular. Finally, the high values of the A-HeLD-14 total score, indicating a ceiling effect, might also have influenced our results and made it more difficult to obtain significant findings. We believe the variables we included were relevant (Blizniuk et al., 2015; Mohd-Dom et al., 2015). However, based on the odds ratios, it seems that the moderator variables had little influence on the associations, particularly for the toothbrushing models. This indicates that the moderator variables may not be the most relevant and that others, such as access to dentist or having the energy for toothbrushing, could have been included.

This study also has several strengths. The sample was randomly collected from the entire target population in the Eastern Province of KSA. As no governorates were excluded, the sample can be considered to represent the target group, and it included participants of varying socio-economic status from urban and rural areas. These factors might contribute to the generalisability of the study findings. Moreover, the sample for this study was considerably large, and the study had a nearly 100 % response rate, which helped to provide robust results. The sample was collected from a school setting rather than health-care services, hospitals or dental clinics, which enabled OHL and oral health-related behaviours to be assessed in a natural setting and thus avoided sampling bias.

5. Conclusion

This study found that poor OHL is significantly associated with low frequency of toothbrushing and irregular dental attendance. Our results indicate that OHL is an important factor to consider when planning, designing, and implementing effective intervention programmes to promote oral health. Interventions that improve individuals' capability to pay attention to their oral health as well as improve their utilisation of oral health information seem especially warranted to improve daily oral hygiene, whereas systemic changes related to access and financial subsidy seem relevant for improving the use of the dental care system.

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Declaration of competing interest

The authors declare that they have no known competing financial

interests or personal relationships that could have appeared to influence the work reported in this paper.

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Ethical Statement

Prior to the data collection, the research protocol was approved by the Institutional Review Board at King Saud University Medical City in Riyadh, KSA (Approval letter reference number: 21/0309/IRB). The participants were anonymised, and their data were kept confidential. Informed consent was obtained from all parents of the participants prior to data collection.

References

Akinyamoju, C., Taiwo, J., Uwadia, E., Agbogidi, J., Ambeke, A., 2018. Oral health knowledge and practice among traders in Ibadan. Annals of Ibadan Postgraduate Medicine 16 (2), 150–156.

Al Suwyed, A.S., Al Zoman, K.H., Robert, A.A., Al-Nowaiser, A.M., Alabdely, M.H., Al Mubarak, S., 2021. The silent epidemic of common oral diseases among the Arab population: An emerging health problem. Journal of Family Medicine and Primary Care 10 (8), 2768.

Al-Ansari, A.A., 2014. Prevalence, severity, and secular trends of dental caries among various Saudi populations: a literature review. Saudi Journal of Medicine & Medical Sciences 2 (3), 142–150.

AlGhamdi, A., Almarghlani, A., Alyafi, R., Ibraheem, W., Assaggaf, M., Howait, M., Kayal, R., 2020. Prevalence of periodontitis in high school children in Saudi Arabia: a national study. Ann. Saudi Med. 40 (1), 7–14.

Alghamdi, A.K.H., Alsaadi, R.K., Alwadey, A.A., Najdi, E.A., 2022. Saudi Arabia's Vision 2030's compatibility with women and children's contributions to national development. Interchange 53 (2), 193–214.

Alhusseini, N., Ramadan, M., Aljarayhi, S., Arnous, W., Abdelaal, M., Dababo, H., Saleem, N., 2023. Added sugar intake among the saudi population. PLoS One 18 (9), e0291136.

Aljafar, A., Alibrahim, H., Alahmed, A., AbuAli, A., Nazir, M., Alakel, A., & Almas, K. (2021). Reasons for permanent teeth extractions and related factors among adult patients in the Eastern Province of Saudi Arabia. The Scientific World Journal, *2021*.

Alshammari, F.R., Alamri, H., Aljohani, M., Sabbah, W., O'Malley, L., Glenny, A.-M., 2021. Dental caries in Saudi Arabia: A systematic review. Journal of Taibah University Medical Sciences 16 (5), 643–656.

Alzeer, M., AlJameel, A., Rosing, K., Øzhayat, E., 2023. Validation of an Arabic version of the short version of the health literacy in dentistry scale. BMC Oral Health. The paper under review.

American Dental Association, 2006a. Transactions, Chicago. ADA 2006, 316.

American Dental Association, 2006b. Transactions, Chicago. ADA 2006, 317.

Appukuttan, D.P., 2016. Strategies to manage patients with dental anxiety and dental phobia: literature review. Clin. Cosmet. Investig. Dent. 35–50.

Bado, F.M.R., De Checchi, M.H.R., Cortellazzi, K.L., Ju, X., Jamieson, L., Mialhe, F.L., 2020. Oral health literacy, self-rated oral health, and oral health-related quality of life in Brazilian adults. Eur. J. Oral Sci. 128 (3), 218–225.

Badran, A., Keraa, K., Farghaly, M.M., 2023. The impact of oral health literacy on dental anxiety and utilization of oral health services among dental patients: a cross sectional study. BMC Oral Health 23 (1), 146.

Bahamma, M., Hassan, M., 2014. Validity, and reliability of an arabic version of the modified dental anxiety scale in saudi adults. Saudi Med J. 35 (11), 1384–1389.

Baskaradoss, J.K., 2016. The association between oral health literacy and missed dental appointments. J. Am. Dent. Assoc. 147 (11), 867–874.

Baskaradoss, J.K., 2018. Relationship between oral health literacy and oral health status. BMC Oral Health 18, 1–6.

Batista, M.J., Lawrence, H.P., Sousa, M.d.L.R.d., 2018. Oral health literacy and oral health outcomes in an adult population in Brazil. BMC Public Health 18 (1), 1–9.

Bennett, I.M., Chen, J., Soroui, J.S., White, S., 2009. The contribution of health literacy to disparities in self-rated health status and preventive health behaviors in older adults. The Annals of Family Medicine 7 (3), 204–211.

Blizniuk, A., Ueno, M., Zaitsu, T., Kawaguchi, Y., 2015. Association of oral health literacy with oral health behaviour and oral health status in Belarus. Community Dent Health 32 (3), 148–152.

Bokhari, A.M., Quadri, M.F.A., 2020. What factors contribute to the self-reported oral health status of Arab adolescents? An assessment using a validated Arabic-WHO tool for child oral health (A-OHAT). BMC Oral Health 20, 1–10.

Brega, A.G., Jiang, L., Johnson, R.L., Wilson, A.R., Schmiege, S.J., Albino, J., 2020. Health literacy and parental oral health knowledge, beliefs, behavior, and status among parents of American Indian newborns. J. Racial Ethn. Health Disparities 7, 598–608.

Brothwell, D.J., Jay, M., Schönwetter, D.J., 2008. Dental service utilization by independently dwelling older adults in Manitoba, Canada. J. Can. Dent. Assoc. 74 (2).

Buja, A., Grotto, G., Montecchio, L., De Battisti, E., Sperotto, M., Bertoncello, C., Baldo, V., 2021. Association between health literacy and dietary intake of sugar, fat and salt: A systematic review. Public Health Nutr. 24 (8), 2085–2097.

Cepova, E., Cicvakova, M., Kolarcik, P., Markovska, N., Geckova, A., 2018. Associations of multidimensional health literacy with reported oral health promoting behaviour among Slovak adults: a cross-sectional study. BMC Oral Health 18 (1), 1–9.

Cooray, U., Aida, J., Watt, R.G., Tsakos, G., Heilmann, A., Kato, H., Osaka, K., 2020. Effect of copayment on dental visits: A regression discontinuity analysis. J. Dent. Res. 99 (12), 1356–1362.

Dieng, S., Cisse, D., Lombrail, P., Azogui-Lévy, S., 2020. Mothers' oral health literacy and children's oral health status in Pikine, Senegal: A pilot study. PLoS One 15 (1), e0226876.

Dutra, L.d.C., de Lima, L.C.M., Neves, É.T.B., Gomes, M.C., de Araújo, L.J.S., Forte, F.D. S., Granville-Garcia, A.F., 2019. Adolescents with worse levels of oral health literacy have more cavitated carious lesions. PLoS One 14 (11), e0225176.

Firmino, R.T., Martins, C.C., Faria, L.d.S., Martins Paiva, S., Granville-Garcia, A.F., Fraiz, F.C., Ferreira, F.M., 2018. Association of oral health literacy with oral health behaviors, perception, knowledge, and dental treatment related outcomes: A systematic review and meta-analysis. J. Public Health Dent. 78 (3), 231–245.

GASTAT (2020). General Authority for Statistics, *Population in Eastern Region by gender, age group, and nationality (Saudi/Non-Saudi)*, General Authority for Statistics Kingdom of Saudi Arabia, from https://www.stats.gov.sa/en/6135, 2020. Accessed in November 2021.

Hagman, J., Wide, U., Werner, H., Hakeberg, M., 2021. Oral health and oral health behavior in young adults with caries disease. BDJ Open 7 (1), 28.

He, J., Yuan, B., Zhou, S., Peng, S., Xu, Y., Cai, H., Hu, T., 2022. Socio-demographic factors, dental status, oral health knowledge and attitude, and health-related behaviors in dental visits among 12-year-old Shenzhen adolescents: a multilevel analysis. BMC Oral Health 22 (1), 1–10.

Horowitz, A.M., Kleinman, D.V., 2008. Oral health literacy: the new imperative to better oral health. Dent. Clin. N. Am. 52 (2), 333–344.

Horowitz, A.M., Kleinman, D.V., 2012. Oral health literacy: a pathway to reducing oral health disparities in Maryland. J. Public Health Dent. 72, S26–S30.

Idrees, M.M., Azzeghaiby, S.N., Hammad, M.M., Kujan, O.B., 2014. Prevalence and severity of plaque-induced gingivitis in a Saudi adult population. Saudi Med. J. 35 (11), 1373.

Ishikawa, H., Nomura, K., Sato, M., Yano, E., 2008. Developing a measure of communicative and critical health literacy: a pilot study of Japanese office workers. Health Promot. Int. 23 (3), 269–274.

Jaafar, A., Al-Kadhim, A., Ab Malik, N., 2020. Oral health literacy among public university undergraduate students and associated factors. IIUM Medical Journal Malaysia 19 (3).

Jackson, R.D., Eckert, G.J., 2008. Health literacy in an adult dental research population: a pilot study. J. Public Health Dent. 68 (4), 196–200.

Jones, M., Lee, J.Y., Rozier, R.G., 2007. Oral health literacy among adult patients seeking dental care. J. Am. Dent. Assoc. 138 (9), 1199–1208.

Jones, K., Parker, E., Mills, H., Brennan, D., Jamieson, L., 2014. Development and psychometric validation of a Health Literacy in Dentistry scale (HeLD). Community Dent Health 31 (1), 37–43.

Ju, X., Brennan, D., Parker, E., Chrisopoulos, S., Jamieson, L., 2018. Confirmatory factor analysis of the health literacy in dentistry scale (HeLD) in the Australian population. Community Dent Health 35 (3), 140–147.

Khajuria, S., Koul, M., Khajuria, A., Surgeon, D., Kashmir, I., 2019. Association between oral health behavior and oral health literacy among college students. Int J Appl Dent Sci 5 (4), 86–90.

King, S., Thaliph, A., Laranjo, L., Smith, B.J., Eberhard, J., 2023. Oral health literacy, knowledge and perceptions in a socially and culturally diverse population: a mixed methods study. BMC Public Health 23 (1), 1446.

Lee, H.Y., Lee, J., Kim, N.K., 2015. Gender differences in health literacy among Korean adults: do women have a higher level of health literacy than men? Am. J. Mens Health 9 (5), 370–379.

Maida, C.A., Marcus, M., Hays, R.D., Coulter, I.D., Ramos-Gomez, F., Lee, S.Y., Shen, J., 2015. Child and adolescent perceptions of oral health over the life course. Qual. Life Res. 24, 2739–2751.

Mialhe, F.L., Bado, F.M.R., Ju, X., Brennan, D.S., Jamieson, L., 2020. Validation of the health literacy in dentistry scale in Brazilian adults. Int. Dent. J. 70 (2), 116–126.

Ministry of Health. *Oral and Dental Diseases – Facts on Oral and Dental Health [Internet]*. [cited 2021 May 7]. Available from: https://www.moh.gov.sa/en/HealthAwareness/EducationalContent/Diseases/DiseasesOralanddental/Pages/OralandDentalHealth.aspx.

Mohd-Dom, T.N., Ying, N.Y., Ming, L.S., Moho-Said, S., Yusof, N., 2015. Oral health literacy and behavior of health sciences university students. Journal of Dentistry Indonesia 22 (2), 56–62.

Neves, É.T.B., da Costa Dutra, L., de Lima, L.C.M., Perazzo, M.F., Ferreira, F.M., Paiva, S. M., Granville-Garcia, A.F., 2023. Structuring of the effects of oral health literacy on dental caries in 12-year-old adolescents. Commun. Dent. Oral Epidemiol. 51 (5), 864–871.

Noor, N.M., Rani, H., Zakaria, A.S.I., Yahya, N.A., Sockalingam, S., 2020. Sociodemography, oral health status and behaviours related to oral health literacy. Pesquisa Brasileira Em Odontopediatria e Clínica Integrada 19.

Parker, E.J., Jamieson, L.M., 2010. Associations between indigenous Australian oral health literacy and self-reported oral health outcomes. BMC Oral Health 10 (1), 1–8.

Peres, M.A., Antunes, J.L.F., Watt, R.G., 2021. Oral Epidemiology. In: A Textbook on Oral Health Conditions, Research Topics and Methods. Springer Nature Switzerland AG, Switzerland, pp. P307–P318.

Published, 19th March 2015.. The United Kingdom.

Qataberi, H.A., Ahmed, I.M., Alrifaie, H.F., Albrahimi, D., Al Somaly, H., Almansouri, F., Wali, M., Barabea, D., Mansoor, A., Haraka, S., 2020. Prevalence and Severity of Plaque-Induced Gingivitis among Saudi Adult Population in Jeddah Region. International Journal of Medical Research & Health Sciences. 9 (10), 15–21.

Rahardjo, A., Wachid, M.N., Adiatman, M., Wimardhani, Y.S., Maharani, D.A., 2016. Health literacy in dentistry among undergraduate students in Indonesia. Asian Journal of Epidemiology 9 (1–3), 24–29.

Ramos-Gomez, F., Tiwari, T., 2021. Oral Health Literacy Framework: The Pathway to Improved Oral Health. J. Calif. Dent. Assoc. 49 (12), 759–769.

RCG. *Random Choice Generator*. Available from: https://www.textfixer.com/tools/random-choice.php. Accessed in November 2021.

Rizqi, T.R., Thearmontree, A., 2020. Relationship between health literacy and toothbrushing practice among young adults. Journal of International Oral Health 12 (7), 41.

Schneider, S.L., 2013. The International Standard Classification of Education 2011. In: Elisabeth Birkelund, G. (Ed.), Class and Stratification Analysis, Vol. 30. Emerald Group Publishing Limited, pp. 365–379.

Sermsuti-Anuwat, N., Pongpanich, S., 2019. Validation of Thai version of the health literacy in dentistry scale: Validation among Thai adults with physical disabilities. J. Invest. Clin. Dent. 10 (4), e12474.

Shubayr, M.A., Kruger, E., Tennant, M., 2021. Assessment of dental healthcare services and workforce in the Jazan Region, Saudi Arabia. Saudi J Oral Dent Res 6 (1), 81–87.

Siddiqui, A.A., Al-Enizy, A.S., Alshammary, F., Shaikh, S., Amin, J., 2021. Oral health in Saudi Arabia. Handbook of Healthcare in the Arab World 3511–3536.

Singh, O., Pradhan, D., Sharma, L., Srivastava, R., 2022. Oral health knowledge, attitudes and practices of primary healthcare workers of Lucknow district: A cross-sectional study. Journal of Family Medicine and Primary Care 11 (2), 520.

Sistani, M.M.N., Virtanen, J., Yazdani, R., Murtomaa, H., 2017. Association of oral health behavior and the use of dental services with oral health literacy among adults in Tehran. Iran*European Journal of Dentistry* 11 (02), 162–167.

Sistani, M., Yazdani, R., Virtanen, J., Pakdaman, A., Murtomaa, H., 2013. Oral health literacy and information sources among adults in Tehran. Iran*Community Dent Health* 30 (3), 178–182.

Sowmya, K., Puranik, M.P., Aparna, K., 2021. Association between mother's behaviour, oral health literacy and children's oral health outcomes: A cross-sectional study. Indian J. Dent. Res. 32 (2), 147–152.

Sukhabogi, J.R., Doshi, D., Vadlamani, M., Rahul, V., 2020. Association of oral health literacy with oral health behavior and oral health outcomes among adult dental patients. Indian J. Dent. Res. 31 (6), 835.

Survey on the perceived oral health among Danes above 40 years. Danish Dental Association. September 2020. In Danish.

Tabassum, A., Madi, M., Alabdulaziz, A., Al Nasrallah, Y., Alabdulaziz, M., Siddique, I.A., Kazmi, F., 2022. Prevalence of periodontitis based on retrospective radiographic evaluation at dental hospital in Eastern Province of Saudi Arabia: A retrospective study. The Saudi Dental Journal 34 (8), 788–794.

Tu, R.Y., Liang, P., Tan, A.J.M., Tran, D.H.G., He, A.M., Je, H., Kroon, J., 2023. Factors associated with regular dental attendance by aged adults: A systematic review. Gerodontology 40 (3), 277–287.

Tyagi, U., Menon, I., Tomar, D., Singh, A., Goyal, J., 2017. Association between maternal oral health literacy and their preschoolers' oral health outcomes in Muradnagar—A cross-sectional study. J Dent Specialities 5 (2), 98–101.

Ueno, M., Takeuchi, S., Oshiro, A., Kawaguchi, Y., 2013. Relationship between oral health literacy and oral health behaviors and clinical status in Japanese adults. Journal of Dental Sciences 8 (2), 170–176.

Wehmeyer, M.M., Corwin, C.L., Guthmiller, J.M., Lee, J.Y., 2014. The impact of oral health literacy on periodontal health status. J. Public Health Dent. 74 (1), 80–87.

Who, 2023. Global oral health status report—towards universal health coverage for oral health by 2030. Retrieved from https://www.who.int/team/noncommunicable-diseases/global-status-report-on-oral-health-2022. Date accessed: September 07,. 2023.

Wigen, T.I., Skaret, E., Wang, N.J., 2009. Dental avoidance behaviour in parent and child as risk indicators for caries in 5-year-old children. Int. J. Paediatr. Dent. 19 (6), 431–437.

Xu, M., Cheng, M., Gao, X., Wu, H., Ding, M., Zhang, C., Hu, D., 2020. Factors associated with oral health service utilization among adults and older adults in China, 2015–2016. Commun. Dent. Oral Epidemiol. 48 (1), 32–41.