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Evaluation of the Oral Health Status and the Impact of Oral Health Promotion in a Group of Egyptian Children with Chronic Liver Disease

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Aim: The current study aimed to evaluate the oral health status of chronic liver diseased children in terms of caries experience, oral hygiene, gingival health, the presence or absence of staining or developmental teeth defects, and to evaluate the impact of oral health promotion on the oral health status of these children after a 6-month-follow up period.

Materials and Methods: Sixty children diagnosed with chronic liver disease (CLD) were examined. Caries prevalence was recorded using DMFT/dmf/def indices for permanent, primary and mixed dentitions, respectively. Developmental enamel defects and oral hygiene index scores were also investigated. Oral health education of patients and their caregivers was carried out and the same parameters were investigated again after a 6-month-follow-up period to assess the impact of oral health promotion.

Results: Children with CLD demonstrated high caries experience in their primary, mixed and permanent dentitions, with mean values of 5.88±4.37, 4.19±2.42, 2±2.18, respectively. Most of the children had substandard oral health conditions with mean values of OHI-S (1.73±0.74). Developmental defects of enamel with varying presentations were evident in 16.67% of the children. No statistically significant differences were found in DMFT/dmf/def scores before and after oral health promotion, however significant reduction in OHI-S mean value (0.90±0.60) was found after 6-months following oral health promotion.

Conclusion: Children diagnosed with CLD exhibited inadequate oral hygiene status, together with high prevalence of dental caries. It is evident that education and preventive measures lead to positive improvements in the oral health of children with CLD.

Keywords: Hepatic disease, oral hygiene, caries, enamel defects, oral health education.

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Introduction

Chronic liver disease (CLD) is a condition commonly observed in children and adolescents. It signifies long-standing and irreversible damage to the liver's structure, potentially leading to fibrosis and cirrhosis. Liver cirrhosis, a consequence of CLD, can be particularly severe and fatal in pediatric patients.[1]

Etiology of CLD in children encompasses a wide range of conditions distinct from those seen in adults. These include infections, developmental abnormalities, metabolic disorders, genetic anomalies, and autoimmune diseases, all of which have the potential to culminate in hepatic failure.[2]

Complications arising from CLD predominantly stem from the extent of hepatic impairment. These include conditions such as portal hypertension, cholestasis, improper protein formation, coagulation disorders, alongside impaired immunity, nutritional imbalance and metabolic disturbance, all of which elevate their susceptibility to microbial infections and malnutrition.[3]

Patients with CLD often exhibit substandard oral health, characterized by various oral manifestations that may be causal, coincidental or secondary to therapeutic intervention.[4] Previous studies showed that children with CLD had higher frequency of untreated caries, poorer oral hygiene and gingival health. The authors suggested that the utilization of sugared oral medications, excessive consumption of unhealthy snacks rich in fermentable carbohydrate between meals, the use of diuretic drugs, the absence of specialist dental treatment for those children and the parents' or caregivers' focus on the child's medical condition might be the contributing factors.[5-8]

Developmental defects of enamel, intrinsic green staining of the teeth and oral mucosal lesions associated with CLD were also reported in literature. The different oral findings vary depending on the type and severity of the liver disease.[5,8-10]

It is important to address, as early as possible, the oral and dental problems in liver diseased children, and to provide for a tailored oral health education program to prevent the emergence of those problems or prevent their complications.

Unfortunately, there is limited information available on the oral health status of liver diseased children in Egypt, and to our best of knowledge, no previously published studies have attempted to promote oral health of children with CLD by oral health education or any preventive programs. Hence, this study aimed to explore the oral health condition and dental problems, and to assess the effectiveness of oral health education among a group of Egyptian children diagnosed with CLD. The null hypothesis of this study is that there will be no difference between oral hygiene status of children with CLD before and after oral health promotion.

Materials and Methods

The research protocol was approved by Faculty of dentistry, Ain Shams University ethical committee under the ethical approval number (FDASU-Rec IM012226). Written Parental informed consents and children's oral assents were acquired prior to the study.

Study design

The present study was designed as a quasi-experimental study.

Sample size

A power analysis was designed to have adequate power to apply a statistical test of the null hypothesis that there is no difference would be found in the oral hygiene status before and after oral health education in children with CLD. By adopting an alpha level of (0.05) a beta of (0.2) i.e., power=80% and an effect size (d) of (0.809) calculated based on the results of previous study[5]; the predicted sample size (n) was a total of (50) cases. Sample size was increased by (20%) to compensate for possible dropouts during follow-up intervals to be (60) cases. Sample size

calculation was performed using G*Power version 3.1.9.7.[11]

Study population

A sample of 60 children with CLD attending Dr. Yassin Abdel Ghaffar Charity Center for Liver Diseases & Researches, with age range between (3-14 years old) were recruited for the study. Patients with any other chronic disorder or uncontrolled medical condition and patients whose parents refuse to sign an informed consent were excluded from the study.

Study procedures

The present study was conducted in two phases, including a 6-month follow-up period in-between.

Phase I

- Questionnaire Data

A structured questionnaire was employed to gather information such as demographic details, comprehensive medical and dental history, together with oral hygiene practices and dietary habits (e.g. frequency of tooth brushing, frequency of unhealthy snacking and regular dental checkups), obtained from the caregiver and the child through a face-to-face interview.

- Clinical examination

A single examiner conducted the clinical examination of the participants both at baseline and follow-up. Prior to the commencement of the study, the examiner underwent training in accordance with the diagnostic criteria outlined by the WHO[12]. This training involved assessing 10 pediatric patients who were not part of the study.

Dental caries experience was evaluated using the decayed, missing, and filled index for the primary, mixed and permanent teeth (dmft/deft/DMFT).[12] The oral hygiene was assessed using the Simplified Oral Hygiene Index (OHI-S). The (OHI-S) consists of simplified debris index (DI-S) and simplified calculus index (CI-S). To obtain the OHI-S for each child, both debris and calculus scores were calculated separately, and added together.[13]

Developmental defects of enamel were assessed using the modified developmental defects of enamel index (DDE modified Index)[14], where the type (demarcated opacity, diffuse opacity, or hypoplasia), color (white/cream or yellow/brown) and extent of the defects on all teeth surfaces were determined. The presence or absence of intrinsic teeth staining was visually evaluated on the buccal and labial surfaces of all teeth. Examination of all the oral soft and hard tissues was carried out to identify soft tissue or osseous abnormalities.[15]

- Oral health promotion

After clinical examination, oral health education of the child and his/her caregiver was done using a specially designed booklet, which includes instructions about daily routine oral hygiene measures, dietary modifications and importance of regular dental checkups tailored specifically for liver diseased children. It also includes information about the expected oral diseases that can be associated with liver diseases and how to prevent and manage each case. Oral hygiene measures including tooth brushing techniques and flossing were demonstrated on a model by the examiner and the child was asked to repeat what he/she learnt. Finally, Fluoride application was done for all cases regardless of the caries experience.

Phase II

After 6 months, the caregiver was called to visit the clinic with the child where the effectiveness of the oral hygiene education was evaluated for all participants by performing the same indices used in phase I. The outcomes were then compared with the baseline data. The health education components were reinforced again at the follow-up visit.

Statistical analysis

The collected data were analyzed utilizing the Statistical Package for the Social Sciences, version 23.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean ± standard

deviation in cases where they followed a parametric (normal) distribution, whereas non-normally distributed variables (non-parametric data) were presented as median with inter-quartile range (IQR). Qualitative variables were presented as counts and percentages. Normality of the data was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. Comparison between paired non-parametric data of two periods was done using Wilcoxon Signed-Rank Sum test. McNemar's test from Chi-square test was used to examine the relationship between pre-program and post-program (paired) qualitative variables. P-value <0.05 was considered significant.

Results

Sociodemographic data

The summary statistics of sociodemographic data is presented in Table (1).

Table 1: Sociodemographic data comprising gender, age and place of residence distribution among study group.

Sociodemographic data	Total (n=60)
Gender	
Female	28 (46.7%)
Male	32 (53.3%)
Age (years)	
Mean±SD	8.90±3.37
Median (IQR)	9 (6-12)
Residence	
Cairo	27 (45.0%)
Outside Cairo	33 (55.0%)

Out of the 60 enrolled children, 8 children (13.33%) dropped out from the study and were not available for reevaluation in the follow up phase (Phase II) after six months. Males (n=5) constituted 62.5% and females (n=3) constituted 37.5% of the dropped-out cases, with mean age of 9.25±3.61. Reasons for the loss to follow up were distant accommodation (n=4), lost communication with the parents (n=3) and death of one of the participants (n=1).

Dental history

Summary statistics for dental history among the study group is presented in Table (2).

Table 2: Summary statistics for dental history among the study group.

Dental history	Total (n=52)
Frequency of teeth brushing	
No	28 (53.8%)
Once daily	12 (23.1%)
Twice Daily	3 (5.8%)
Irregular	9 (17.3%)
Extra cleaning devices as flossing or fluoridated mouth wash	
No	52 (100%)
Frequency of unhealthy snacking	
Once daily	14 (26.9%)
Twice Daily	16 (30.8%)
Three Times Daily	10 (19.2%)
Irregular, not daily (Controlled)	12 (23.1%)
Regular dental check ups	
No	49 (94.23%)
Yes	3 (5.77%)

Clinical examination

The majority of cases (41.7%) were in the mixed dentition stage, while 33.3% had pure primary dentition and 25% had pure permanent dentition. Only 3 out of 60 children (5%) presented soft tissue anomalies, including fissured tongue, swollen tongue papilla and severely jaundiced gingiva. Some (16.67%) of the studied children showed some type of DDE, with demarcated opacities evident in 4 children (6.7%), diffuse opacities evident in 4 children (6.7%), and hypoplasia evident in only 2 children (3.3%). The prevalence of delayed eruption among the study group was 11.66% with the majority having normal eruption patterns. The

presence of intrinsic staining of teeth was evident in only 1 child (1.7%).

Effect of oral health promotion

The effect of oral health promotion was studied by comparing the values of oral hygiene practices and diet, together with caries experience, oral hygiene and gingival health values before and after oral health promotion. The drop-out cases were excluded from correlation before and after oral health promotion.

Effect of oral health promotion on oral hygiene practices (frequency of tooth brushing) and diet control is presented in Figures (1) and (2).

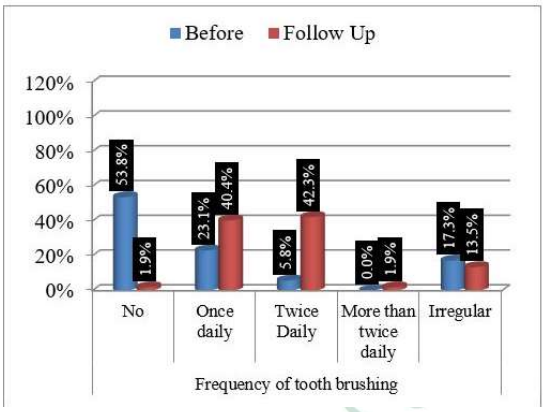

Figure 1: Comparison between frequency of tooth brushing before and after oral health promotion.

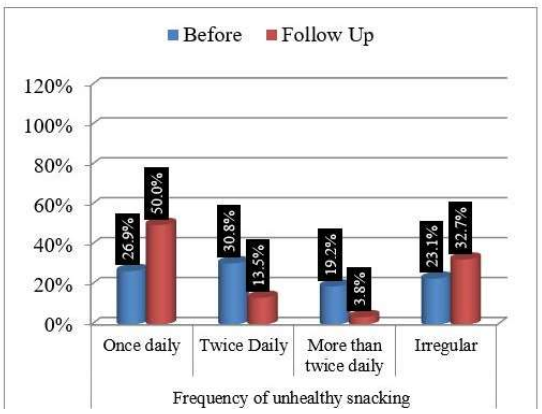

Figure 2: Comparison between frequency of unhealthy snacking before and after oral health promotion

McNemar's test showed statistically significant higher frequency of tooth brushing in follow up after oral health promotion compared to baseline data, with p-value ($p \leq 0.001$). Additionally, there was a statistically significant difference between baseline and follow up regarding frequency of unhealthy snacking, being lower in the follow up, with p-value ($p<0.05$).

Effect of oral health promotion on oral hygiene and gingival indices is presented in Table (3).

Wilcoxon Signed-Rank Sum test showed significant reduction in oral hygiene index after health promotion ($p<0.05$). There was a highly significant increase in percentage of cases with good oral hygiene and a significant reduction of cases with fair and poor oral hygiene ($p<0.001$).

Table 3: Summary statistics for oral hygiene and gingival indices before and after oral health promotion.

Index	Before (n=52)	Follow Up (n=52)	p-value	Sig.
Oral hygiene OHI-S - Score				
Mean±SD	1.73±0.74	0.90±0.60	<0.001*	HS
Median (IQR)	1.6 (1.2-2.3)	0.7 (0.4-1.2)		
Oral hygiene OHI-S Rating				
Good	14 (26.9%)	40 (76.9%)	<0.001*	HS
Fair	37 (71.2%)	12 (23.1%)		
Poor	1 (1.9%)	0 (0.0%)		

NS: Non-significant; S: Significant; HS: Highly significant

The effect of oral health promotion on caries experience is presented in Table (4). For all caries experience in primary, mixed and permanent dentitions, Wilcoxon Signed-Rank Sum test showed no statistically significant difference ($p>0.05$) between caries prevalence before and after oral health promotion.

Table 4: Summary statistics of caries experience before and after oral health promotion.

Caries experience	Before (n=52)	Follow Up (n=52)	p-value	Sig.
DMF				
Mean±SD	2±2.18	2.08±2.25	0.854	NS
Median (IQR)	1.5 (0-3)	2 (0-3)		
DMF (Mixed)				
Mean±SD	0.95±1.43	0.95±1.43	0.992	NS
Median (IQR)	0 (0-2)	0 (0-2)		
dmf				
Mean±SD	5.88±4.37	5.94±4.55	0.984	NS
Median (IQR)	6 (2-9)	6 (0.5-9.8)		
def				
Mean±SD	4.19±2.42	3.23±2.19	0.186	NS
Median (IQR)	4 (2-6)	3 (1-5)		

NS: Non-significant; S: Significant; HS: Highly significant

Discussion

Chronic liver disease (CLD) among children and adolescents typically arises from a factor causing direct damage to liver cells which may cause a number of local and systemic complications and pathologies within other organs and systems.[16] Literature indicated that CLD negatively impacts the oral cavity, exhibiting a variety of symptoms which include dental caries, dental developmental defects, periodontal diseases, oral mucosal lesions and infections, petechiae or excessive gingival bleeding with minimal trauma.[17]

Results of the current study revealed that the mean age of the studied children is 8.90±3.37 years old. The percentage of males (53.3%) was slightly higher than the percentage of females (46.7%), which can be explained by increased prevalence of liver disease among males as reported in previous research.[6,18-20] However, Baygin et al.[5] reported female predominance. Results also revealed that 55% of the studied children lived outside Cairo and travelled to follow up and receive their treatments indicating limited availability of specialized institutions in treatment of liver diseases across the country.

At baseline, the results of the present study showed inappropriate oral hygiene practices among the studied children and only 5.77% of the parents reported having regular dental checkups for their children, which might be attributed to the difficulty in finding experienced dentists in the care of their children with liver disease and being preoccupied with hospital visits, potentially hindering their ability to prioritize regular dental check-ups.[21,22] Also, the majority of children (50%) had unhealthy snacks at least twice daily. These findings are supported by Hosey et al.[22], who stated that children with CLD often consumed excessive fermentable carbohydrate rich snacks between meals due to poor fat metabolism together with tailored dietary restrictions and the need for high concentration of sugars to provide for the necessary calories. Six months following oral health education, there was a highly significant increase in the frequency of tooth brushing among the studied children, where prevalence of children who did not brush their teeth at all dropped from 53.8% to only 1.9%. Also, there was a significant reduction in the frequency of unhealthy snacking among the studied children.

Results of clinical examination showed that soft tissue anomalies were found in only 5% of the children, while the majority showed no soft tissue or mucosal lesions. Soft tissue anomalies were also reported previously by Baygin et al.[5], who found mucosal lesions in 16.1% of his studied group. Interestingly, Olczak et al.[10] found mucosal lesions in 74% of children with CLD which is a much higher prevalence than the current study, while Sheehy et al.[23] and Alanzi et al.[6] reported absence of mucosal lesions in their studied groups of children with CLD.

Developmental defects of enamel (DDE) with variable presentations were found in 16.66% of the children. This finding is in accordance with previous studies[5,6,8,10,24] that reported varying prevalences of DDE among their study groups. DDE in CLD occurs due to the malnutrition and metabolic disturbances.[5,25] The variation encountered

among the different studies is because DDE is dependent on the age of target population at which CLD occurred as malnutrition and metabolic disturbances affect teeth during earlier phases of development.

Intrinsic teeth staining (greenish discoloration) was observed in only 1 case, which had biliary atresia, with prevalence of 1.7%. This finding is in agreement with previous studies[5,7,8,24], however higher prevalences were reported. The low prevalence of intrinsic tooth staining in the current study can be explained by the low prevalence of cholestatic liver diseases as Biliary Atresia (BA) and Primary familial intrahepatic cholestasis (PFIC) (3.33%). Intrinsic teeth staining in liver disease is caused by a buildup of conjugated bilirubin in the teeth as a result of cholestatic illness, if the illness occurred during the period of teeth development.[26]

The prevalence of delayed teeth eruption was relatively low, being 11.66%. Delayed eruption in CLD can be explained by nutritional deficiencies in vitamin A, which normally is absorbed and stored by the liver, and involved in bone growth, and vitamin D, which is activated by the liver, and is involved in calcification of bones. Other contributing causes may be malnutrition caused by CLD and corticosteroid therapy.[27,28]

Regarding assessment of oral hygiene status, only 26.9% of the studied children showed good oral hygiene status, while the majority of children (71.2%) showed fair oral hygiene status. The poor oral hygiene status among the study group in the current study is in alignment with the work of Baygin et al.[5] , Olczak et al.[10], Wondimu et al.[24], and Alanzi et al.[6], who described poorer oral hygiene status in children with CLD when compared with controls. The findings, however, disagree with Vidigal et al.[8], who reported that 56.7% of his study group of liver diseased children showed excellent or good oral hygiene status. Also, Sheehy et al.[23] reported similar plaque levels between liver diseased group and control group. The difference might be attributed to different geographic distribution, higher socioeconomic level and improved awareness.

The OHI-S showed a highly significant improvement after oral health education, with significant increase in the prevalence of good oral hygiene and reduction of fair and poor oral hygiene status. The effectiveness of oral health education in improvement of oral hygiene status is supported by previous studies[29,30,31] performed on medically compromised children, but neither of them studied children with CLD.

Regarding assessment of caries experience, the baseline results revealed that only 16.66% of the studied children were caries free. The relatively high prevalence of dental caries in the primary dentition (dmft) presented in the current study is supported by the work of Lin et al.[7], Olczak et al.[10], and Alanzi et al.[6], who reported similar dmft values in their study groups, but is not in agreement with Sheehy et al.[23] , Wondimu et al.[24] and Baygin et al.[5] , who reported a significantly lower dental caries prevalence (dmft of 1.22, 2.0 ±2.8 and 0.16±0.17, respectively). The low caries prevalence in the permanent dentition is consistent with the findings of Baygin et al.[5] and Sheehy et al.[23] but contrary to Olczak et al.[10] and Alanzi et al.[6] , who reported higher values of DMFT in their study groups with values 8.92±38 and 4.2±4.6 respectively. The low DMFT values in the current study can be attributed to the lower mean age of the studied children and the fact that recently erupted permanent teeth are commonly caries-free.

The DMFT/dmf/def showed no statistical significance between baseline and after oral health education ($p>0.05$) because preventive measures are ineffective in irreversible stages of dental caries, while the limited follow-up period (6 months) may not be an enough period to monitor changes in caries experience.

The overall results of this study necessitated the rejection of the null

hypothesis that there would be no difference between oral hygiene status of children with CLD before and after oral health promotion.

The present study examined an important group of special health care needs children. The results of the current study provide insight into their oral health status, and how an oral health promotion initiative positively affected their oral health parameters. Also, examination of all patients was conducted by one trained examiner which strengthens the reliability of the study outcomes.

Limitations

The single centered design prevents generalization of the findings. Also, the current study did not include a healthy control group for comparison of the findings. Furthermore, etiologies of the CLD were heterogeneous.

Conclusion

Children with a history of CLD exhibited inadequate oral hygiene status as reflected by substandard debris scores, together with high prevalence of dental caries. It is evident that education and preventive measures lead to positive improvements in the oral health of children with CLD. Collaborative efforts involving parents/caregivers, children, and dental professionals can play a crucial role in enhancing the notably poor oral health status observed in these children.

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Data availability

The authors confirm that the data supporting the findings of this study are available within the article and its supplementary materials.

Ethical Declaration

The research protocol was approved by Faculty of dentistry, Ain Shams University ethical committee under the ethical approval number (FDASU-Rec IM012226). All participants involved in this study were provided with comprehensive information regarding the research and gave their informed consent/assent prior to participation.

Conflict of interest

The authors declare no conflict of interest.

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