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RESEARCH ARTICLE

Oral Health Assessment Among Adolescent Competitive Swimmers in Gujarat State, India

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Abstract

Introduction: Swimming is a popular sport associated with several health benefits; however, it may also pose unique challenges to oral health. The prevalence of dental issues among swimmers, such as enamel erosion, staining of teeth, increased risk of dental caries, and oral sensitivity, necessitates timely assessment and comprehensive management of oral health. Maintaining optimal oral health is crucial for athletes, especially swimmers, who are frequently exposed to unique oral health challenges. **Objective:** This study aimed to assess the prevalence of oral health conditions among competitive swimmers and to emphasise the need for greater awareness and proactive measures to ensure their long-term dental well-being by highlighting the importance of maintaining oral hygiene practices and regular dental check-ups. **Materials and Methods:** *Design*: Cross-sectional observational study. *Setting*: Gujarat Aquatic Championships (June 29–30, 2024). *Participants*: Assessment was conducted among 91 sub-junior and junior competitive swimmers from the Gujarat Aquatic Championships. *Intervention*: Dental Examination of swimmers. *Main Outcome Measures*: The EA4SD/ASD dental protocol using Universal Dental Examination in Sports Form (UDES). **Results:** Statistical analyses, including chi-square tests and logistic regression, identified a significantly higher prevalence of dental erosion (36.71%) among swimmers with more than 3 years of training ($p = 0.02$). The results also showed that 39.24% of swimmers had dental caries, 81.01% had calculus, and 54.43% had dental stains. No correlation was observed between dental stains, gingivitis, and years of swimming training ($p = 1$ and 0.6, respectively). **Conclusion:** The higher prevalence of oral health problems among swimmers highlights the need for targeted preventive strategies, including promotion of fluoride and remineralising therapies and education regarding oral hygiene practices, such as rinsing after

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swimming and delaying brushing until enamel rehardens. Ensuring proper pool maintenance and maintaining neutral pH levels are equally important. Such measures are essential for protecting the oral health and performance of swimmers exposed to acidic chlorinated environments.

1. INTRODUCTION

Swimming is a popular sport associated with several health benefits; however, it may also pose unique challenges to oral health[1]. As aquatic environments expose swimmers to various chemical agents, particularly chlorine, there is potential for adverse effects on oral tissues and overall dental integrity[2]. The prevalence of dental issues among swimmers, such as enamel erosion, increased risk of dental caries, and oral sensitivity, necessitates a comprehensive assessment of oral health tailored specifically to this population. Understanding the relationship between swimming habits and oral health can help develop preventive strategies and educational initiatives for both competitive and recreational swimmers.

Maintaining optimal oral health is crucial for athletes, especially swimmers, who are frequently exposed to unique oral health challenges. Frequent exposure to chlorinated water may increase acid exposure, which can contribute to enamel erosion and subsequent dental problems if appropriate preventive measures are not followed. Additionally, swimmers often consume carbohydrate-rich energy supplements and snacks intended to improve athletic performance. However, frequent intake of carbohydrate-containing products may increase the risk of dental caries and enamel erosion[3].

The influence of oral health on athletic performance should not be underestimated. Poor oral health may lead to discomfort, pain, difficulty in chewing, and distraction during training and competition, thereby negatively affecting performance outcomes[4]. During the 2004, 2012, and 2016 Olympic Games, dental problems were reported as one of the major health concerns among athletes, with many requiring urgent dental care[5].

Chlorinated pool water, although essential for maintaining hygiene, may adversely affect oral health, particularly among competitive swimmers. Prolonged exposure to acidic environments can contribute to enamel erosion and increase susceptibility to oral diseases. Dental erosion occurs due to dissolution of hydroxyapatite crystals and impaired remineralisation of dental hard tissues following prolonged exposure to acids and microorganisms. The solution pH below 5.5 for enamel and below 6.0 for dentin is considered the critical pH for progression of dental erosion[6]. Competitive swimmers may also exhibit higher levels of cariogenic microorganisms, such as *Streptococcus mutans*, which can be aggravated by acidic pool environments and dehydration-induced dry mouth[7,8].

By emphasising the importance of maintaining oral hygiene practices and regular dental check-ups, this study aims to create greater awareness and encourage preventive measures to ensure the long-term oral health and well-being of swimmers.

2. METHODOLOGY

A cross-sectional observational study was conducted among competitive swimmers participating in the Gujarat Sub-Junior and Junior Aquatic Championship held on 29–30 June 2024.

The swimmers and their parents voluntarily provided consent for oral health screening and educational sessions, along with approval from the championship authorities. Written informed consent was obtained from all participants prior to examination.

Permissions were obtained from Savvy Swaraj Sports Complex, Ahmedabad; Ahmedabad Swimmer Sports Complex; and Government Dental College and Hospital (GDCH), Ahmedabad. All approvals were obtained through IASD and IDA. Sixteen volunteers were trained to assist with dental assessment and oral

health education after obtaining approval from GDCH, Ahmedabad. The study was conducted in accordance with the Declaration of Helsinki and initiated following approval from the Indian Academy of Sports Dentistry (IASD-2025-R-009).

Participant details regarding swimmer demographics, age categories, and parental dental awareness were collected for efficient management of the PCDA. A total of 91 swimmers were included in the study. Six stations were organised for registration, examinations, education, athlete interaction, distribution of goody bags, and vertical educational activities. A single examiner clinically assessed the oral health status of all tooth surfaces under adequate illumination.

Participants included systemically healthy swimmers who had not taken antibiotics during the three months prior to the study. Participants undergoing orthodontic treatment were excluded.

Dental examination was performed according to the Universal Dental Examination in Sports (UDES) protocol developed by the EA4SD (European Association for Sports Dentistry) and ASD (Academy for Sports Dentistry)[9]. The findings were coded and entered into Microsoft Excel 2019. Data were presented as proportions and mean ± standard deviation. Proportions were compared using continuity correction with chi-square testing. Multiple logistic regression analysis was performed to estimate odds ratios for associated factors related to dental erosion (sex, age, and duration of swimming). Independent variables were selected using the backward stepwise method, with entry at p = 0.05 and removal at p = 0.10. Statistical analysis was performed using SPSS version 23 (IBM). The level of significance was set at 5%.

3. RESULTS

A total of 91 competitive swimmers, with a mean duration of swimming of 4.61±3.27, consisting of a higher proportion of males (53.85%), participated in this study. Table 1 shows demographic details.

Participants were from different geographical regions of Gujarat, as depicted in Figure 1, with the

Table 1. Demographic characteristics of study subjects

Variables	Frequency (n)	%
Gender		
Male	49	53.85
Female	42	46.15
Age		
<14 years	36	39.56
>14 years	55	60.44
Swimming duration (in years)	4.61 ± 3.27	
Duration of swimming		
< 3 years	40	43.95
> 3 years	51	56.05

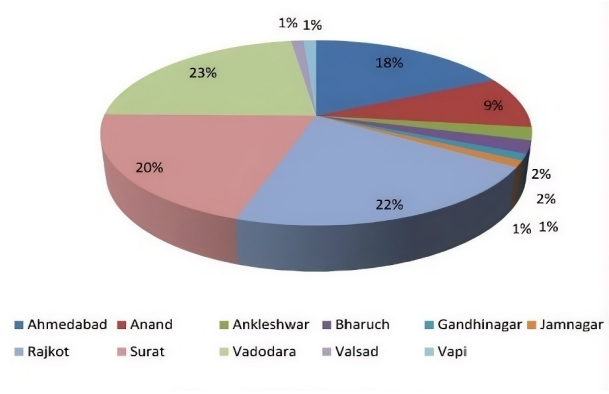


Figure 1. Distribution of swimmers.

Table 2. Dental history of swimmers

Variables	Frequency (n)	%
Dental visits (0-6 months)	10	10.99
Dental visits (6-12 months)	9	9.89
Dental visits (> 12 months)	42	46.15
No visits	30	32.97
Past dental treatment - Yes	20	21.98
Past dental treatment - No	71	78.02

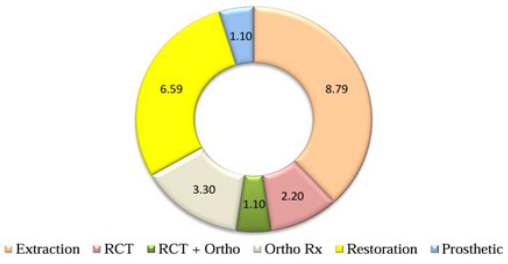


Figure 2. Past dental treatment.

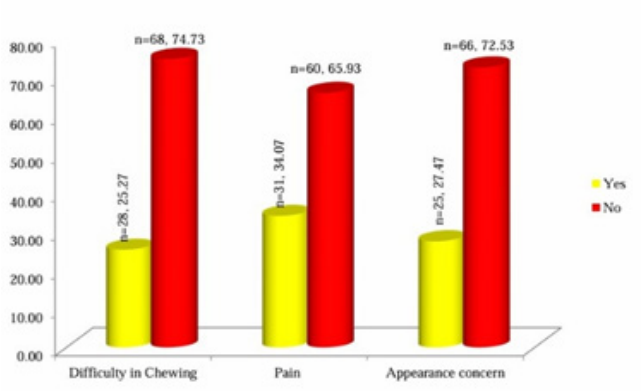


Figure 3. Dental concerns among swimmers.

highest from Vadodara(23%), followed by Rajkot, Surat, Ahmedabad, and Anand.

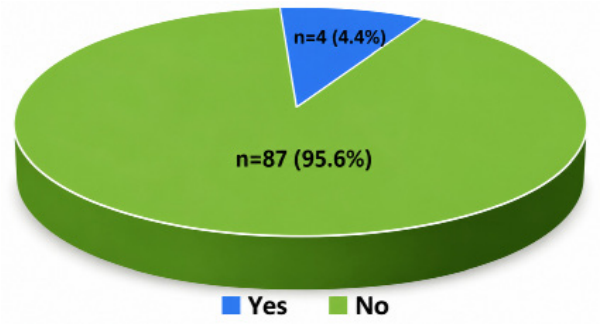


Figure 4. Headache among swimmers.

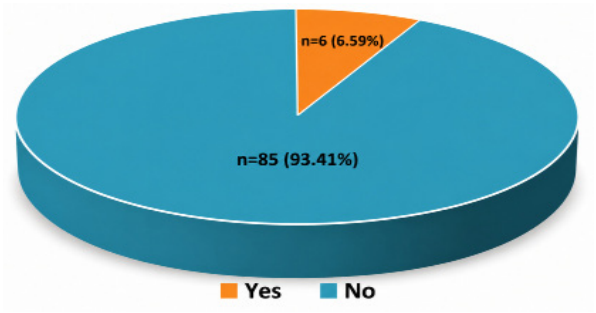


Figure 5. Use of mouthguard among swimmers.

Swimmers' past dental history was recorded as shown in Table 2 and Figure 2, and it was found that 32.97% had not visited the dentist ever, while only 10.99% has went for 6 monthly visit and 21.98% had undergone dental treatment before, among which

Table 3. Cross tabulation between the duration of swimming and dental findings

Dental findings	Duration of swimming n (%) < 3 years (n = 40)	> 3 years (n = 51)	Total (n = 91)	pvalue[a]
Dental erosion	9 (22.50)	26 (51.28)	35 (38.46)	0.02*
Dental caries	22 (55.0)	12 (23.52)	34 (37.36)	0.01*
Dental Calculus	8 (20.0)	16 (33.37)	21 (26.37)	0.28
Gingivitis	31 (77.50)	43 (84.31)	74 (81.31)	0.60
Dental stains	22 (55.0)	27 (52.94)	49 (53.84)	1.00

[a]Proportions were compared by continuity correction, *p<0.05 significant

Table 4. Associated factors for dental erosion by multiple logistic regression

Factors	Erosion Present (%)	COR (95% CI)	AOR (95% CI)
Gender			
Female	33.33	1	
Male	40.82	1.44 (0.53 - 3.89)	NA
Age			
<14 years	33.33	1	
>14 years	42.31	1.21 (0.43 – 3.39)	NA
Duration of swimming			
<3 years	22.50	1	1
>3 years	51.28	3.00 (1.07 – 8.41) *	3.39 (1.28 – 9.00)*
Constant		0.24*	0.31*

COR = Crude odds ratio, AOR = Adjusted odds ratio, 95% CI = 95% confidence interval, NA = Not applicable, *p<0.05 significant

8.79% had undergone RCT followed by restoration in 6.59%.

Pain was the main concern among swimmers, followed by difficulty in chewing and aesthetic appearance, as shown in Figure 3.

Among 91 swimmers, Dental erosion was seen in 26 swimmers with >3 years of swimming, while only in 9 patients with <3 years of swimming (p value-0.02). A statistically significant difference was noted in swimmers with dental caries (p 0.01). Dental calculus, gingivitis and dental stains findings are statistically non-significant as depicted in Table 3.

Table 4 presents the relation between associated factors and dental erosion among competitive swimmers. No gender predilection for dental erosion ($p > 0.05$) was observed. The probabilities of developing dental erosion increased by 3.39 times amongst swimmers who have more than 3 years of swimming experience. An increase in dental erosion was found among those who spent more than 3 years in training sessions.

Swimmers had a history of Headache among 4.4% of swimmers, as seen in Figure 4, and awareness of mouthguard use was limited to 6.59% of them, as shown in Figure 5. None of the Swimmers wore a mouthguard despite knowledge.

4. DISCUSSION

Competitive swimmers are frequently exposed to environmental and behavioural factors that may adversely affect oral health. The prevalence of dental conditions such as enamel erosion, dental staining, increased risk of dental caries, and oral sensitivity highlights the need for timely oral health assessment and preventive care among swimmers.

Dental erosion refers to the loss of tooth structure caused by chemical interaction between dental hard tissues and acidic environments, resulting in dissolution of the tooth surface[10,11]. The acidic environment of swimming pools, which is non-bacterial in origin, may contribute to dentin hypersensitivity[12]. Tooth

wear in young individuals is considered a pathological condition[13].

The present study demonstrated a higher prevalence of dental erosion among swimmers with more than 3 years of swimming experience compared to those with less than 3 years of exposure, with a statistically significant difference ($p = 0.02$). These findings were comparatively higher than those reported in previous international studies conducted by Buczkowska-Radlińska *et al.*[14] and Zebrauskas *et al.*[8].

Dental caries and dental erosion have few similar etiological and risk factors. Furthermore, the acidic environment is reported to increase the growth of Streptococcus mutans, causing dental caries and erosion[15,16]. No significant relationship was observed in Multivariate analysis in this study. 53.84 % of swimmers had stains, 81.31 % had gingivitis, and 37.36 % of them had dental caries. In this study, no association was observed between duration of swimming and dental calculus, stain and gingivitis, whereas the study by Moore *et al*[2] showed the association. This study reports 78.02% hasn't undergone any dental treatment; similarly, Gillam *et al.*[17] reported low claim for dental services was noticed by 75% of participants. Pain was the main concern among swimmers in this study.

Awareness regarding mouthguards was limited among participants, with only 6.59% reporting awareness and none routinely using mouthguards despite existing knowledge, which was similar to the findings reported by Ashwini *et al.*[18] Understanding the etiological and risk factors associated with dental erosion is essential for planning preventive strategies. Preventive measures such as fluoride therapy, calcium- and phosphorus-rich diets, and maintenance of adequate salivary flow may help reduce the risk of erosion and associated oral health complications.

5. CONCLUSION

To prevent oral health hazards among swimmers, professional pool maintenance with careful monitoring of pool water pH is essential. Oral health professionals should be aware of the potential risks associated with prolonged exposure to chlorinated swimming environments and provide early counselling and preventive guidance.

Sports dentists play an important role in athlete education, advocacy, and implementation of preventive strategies among athletes, coaches, sports federations, and pool management authorities. Since complete avoidance of erosive exposure throughout life is not possible, early detection and prevention should be prioritised.

Awareness regarding the adverse effects of excessive chlorination should be improved among pool maintenance personnel. Oral health professionals can also contribute significantly toward promoting personalised mouthguards among competitive swimmers. Brushing immediately after swimming may be detrimental because acidic chlorine temporarily softens the enamel surface. Competitive swimmers should therefore be encouraged to rinse their mouths with water, baking soda solution, or fluoride mouthwash after swimming and use a soft toothbrush for routine oral hygiene maintenance.

6. LIMITATIONS

The present study was limited by a relatively small sample size and inclusion of participants restricted to individuals below 18 years of age. Gender-based variations in oral health status were not evaluated. Furthermore, the clinical assessment was limited to selected teeth and did not include a detailed evaluation of the maxillary and mandibular posterior regions.

The study also did not assess the influence of brushing techniques, mouthwash use, or electric toothbrush usage on tooth staining and other oral health outcomes. In addition, the correlation between swimming pool water pH and oral health parameters was not evaluated. Further longitudinal studies with larger and more diverse populations are recommended to obtain broader insights into the oral health status of competitive swimmers.

7. FUTURE PERSPECTIVES

Future research should include larger multi-centre studies involving swimmers from diverse geographic and socioeconomic backgrounds across India to better understand the relationship between swimming exposure, pool water chemistry, oral hygiene practices, nutrition, and oral health outcomes. Longitudinal studies incorporating clinical, salivary, and microbiological assessments may provide deeper insights into the progression of dental erosion and other oral conditions among competitive swimmers.

Further research should also evaluate the effectiveness of preventive strategies such as fluoride therapy, mouth rinses, oral health education programs, and regular dental screening protocols. Greater emphasis should be placed on interdisciplinary collaboration between sports dentistry professionals, sports authorities, coaches, and educational institutions to develop evidence-based preventive guidelines and oral health promotion programs for young athletes.

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