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Parental Awareness and Perceptions of AI-Based Oral Hygiene Tools: A Cross-Sectional Survey in Gujarat, India

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ABSTRACT

Aim

This study aimed to evaluate parental awareness, oral hygiene practices and perceptions regarding artificial intelligence (AI) based dental technologies among parents of Generation Z and Generation Alpha children. It also assessed preferred learning methods and technological preferences across different parental age and education levels.

Materials and Methods

A descriptive cross-sectional survey was conducted among 712 parents using a structured 20 item questionnaire. Data were analyzed using descriptive statistics and Chi-square tests in SPSS software to determine associations between demographic variables and awareness levels.

Results

Parental age and education were mainly associated with oral health awareness and perceptions of AI-assisted tools ($p < 0.001$). Most respondents (73.8%) considered oral health highly important, though only 37.2% correctly identified that brushing should begin with the eruption of the first tooth. Parents with higher educational levels demonstrated greater awareness (86.7%) and stronger acceptance of AI-based dental tools (91.2%). The most preferred AI features included integration with dental visits (48%) and oral hygiene progress tracking (26.3%).

Conclusion

Parental education and age significantly influence awareness and attitudes toward AI-based oral hygiene

tools. Although general awareness was high, practical implementation knowledge remained limited. Technology-driven oral health education strategies may enhance preventive dental practices among younger generations.

Keywords

Parental awareness, Oral hygiene, Artificial intelligence, Preventive dentistry, Generation Z, Generation Alpha.

INTRODUCTION

Oral health plays a important role in overall well-being, particularly in children, where preventive practices significantly influence long-term dental outcomes. Over the decades, oral hygiene awareness and practices have evolved across generations, influenced by sociocultural factors, technological advancements and accessibility to dental care services. [1]

Earlier generations largely relied on conventional treatment-based approaches, whereas more recent generations have demonstrated increasing emphasis on preventive care and aesthetic considerations. Generation Z (1997–2009) grew up in a digitally connected environment, where health-related information is readily accessible through online platforms and social media. Generation Alpha (born after 2010) represents the first generation fully immersed in advanced digital technologies from early childhood. [1]

The integration of artificial intelligence (AI) into healthcare, including dentistry, has introduced innovative tools such as smart toothbrushes, AI-based diagnostic aids and personalized oral health monitoring systems. [2] These technologies offer real-time feedback and enhanced engagement, potentially improving preventive practices among children.

Parents serve as primary decision-makers and role models in shaping children's oral hygiene habits. However, limited data exist regarding parental awareness, acceptance and preferences toward AI-based oral health technologies, particularly among parents raising Generation Z and Alpha children.

Therefore, the present study aimed to evaluate parental awareness, oral hygiene practices and perceptions regarding AI-based dental technologies and to analyze the influence of age and education on these parameters.

MATERIALS AND METHODS

Ethical clearance was obtained from the Institutional Ethics Committee prior to the commencement of the study (Approval No: IECADC/0112/2025). The study was conducted in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. [3]

A descriptive cross-sectional survey was carried out between November 2024 and January 2025 among parents residing in different regions of Gujarat State, India.

1. **Study Design and Questionnaire Development**

   A structured, close-ended questionnaire comprising 20 multiple-choice questions was developed using Google Forms. The questionnaire was divided into two sections:

- Sociodemographic details (age, gender, educational level, etc.)
- Knowledge, attitude and practices related to children's oral hygiene and awareness regarding Artificial Intelligence (AI)-based dental tools.

The questionnaire was evaluated for content and face validity by a panel of ten experts in Pediatric Dentistry. A pilot study was conducted among 30 parents to assess clarity, feasibility and reliability. Necessary modifications were incorporated based on feedback.

Test–retest reliability was assessed using Cohen's Kappa coefficient (κ = 0.87), indicating strong agreement and high reliability.

2. Sample Size and Sampling

Sample size was calculated using an online sample size calculator with a 95% confidence level and 10% margin of error, which yielded a minimum required sample size of 650 participants.

The questionnaire link was distributed via Gmail and WhatsApp to approximately 900 parents across Gujarat using convenience sampling. A total of 712 completed responses were received and included in the final analysis. Only one parent per household was permitted to participate to avoid duplication.

3. Data Collection and Statistical Analysis

Digital informed consent was obtained from all participants prior to participation. Responses were collected anonymously and confidentiality was strictly maintained. Data were exported to Excel and subsequently analysed using IBM SPSS Statistics version 25. Descriptive statistics, including frequencies and percentages, were computed. The association between demographic variables (age and educational level) and awareness of AI-based oral hygiene tools was analysed using the Chi-square (χ^2) test.

A p-value < 0.05 was considered statistically significant.

RESULTS

1. Association Between Parental Age and Oral Health Awareness

A statistically significant association was observed between parental age and the importance attributed to oral health (χ^2 = 37.282, p < 0.001). Among 712 respondents, 526 (73.8%) considered oral health to be very important for their child's overall well-being. The highest proportion was noted among parents aged >40 years (86.9%), followed by 20–25 years (83%). The lowest awareness was observed in the 26–30-year age group (61.2%) (Fig 1).

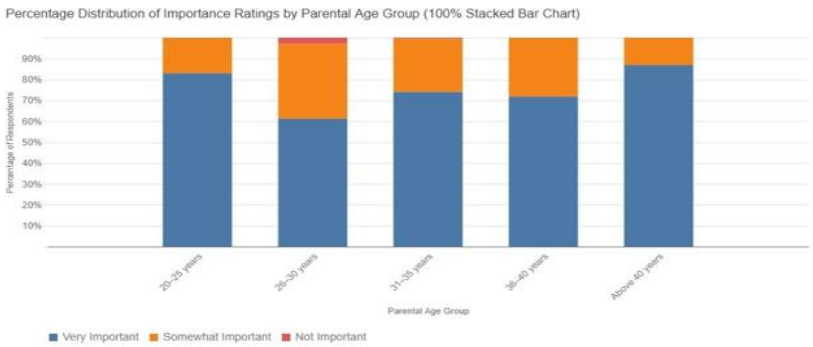

Figure 1: Association Between Parental Age and Oral Health Awareness

A significant association was also found between parental age and awareness of the appropriate time to initiate tooth brushing ($\chi^2 = 43.372$, $p < 0.001$). Only 37.2% of parents correctly identified that brushing should begin with the eruption of the first tooth. Higher awareness was noted among parents aged 31–35 years (44.2%) and >40 years (44.3%), while lower awareness was observed in the 20–25 years (29.5%) and 26–30 years (25.5%) groups.

3.2 Association Between Parental Age and Perception of AI-Based Tools

Parental age showed a statistically significant association with preferred features in AI-based oral hygiene tools ($\chi^2 = 142.204$, $p < 0.001$). Younger parents (20–25 years) primarily preferred real-time feedback on brushing technique (51.1%) and daily reminders (25%). Similarly, parents aged 26–30 years emphasized daily reminders (43.6%) and real-time feedback (30.3%).

Table 1: It shows the association between parental age and preferred features in AI tools.

What is your age?	Real-time feedback on brushing technique	Daily reminders for brushing & flossing	Progress reports on oral hygiene habits	Integration with dental visits & follow-ups (including educational content)
20–25 years	45 (51.1%)	22 (25.0%)	12 (13.6%)	9 (10.2%)
26–30 years	50 (30.3%)	72 (43.6%)	25 (15.2%)	18 (10.9%)
31–35 years	34 (18.8%)	38 (21.0%)	59 (32.6%)	49 (27.0%)
36–40 years	22 (14.1%)	23 (14.7%)	53 (34.0%)	58 (37.2%)
Above 40 years	20 (16.4%)	26 (21.3%)	38 (31.1%)	37 (30.3%)

In contrast, parents aged 31–35 and 36–40 years showed greater preference for oral hygiene progress reports (32.6% and 34.0%, respectively) and integration with dental visits and follow-ups (27.0% and 37.2%, respectively). Parents above 40 years demonstrated similar preferences, favoring progress reports (31.1%) and integration with dental visits (30.3%) (Table 1).

A significant association was also observed between parental age and belief in the effectiveness of AI tools in improving oral hygiene practices ($\chi^2 = 39.593$, $p < 0.001$). Overall, 630 parents (88.5%) agreed that AI tools could enhance oral hygiene practices. The highest acceptance was noted among parents aged 20–25 years (95.5%) and 26–30 years (95.2%), while acceptance gradually declined in older age groups (>40 years: 74.6%) (Fig 2).

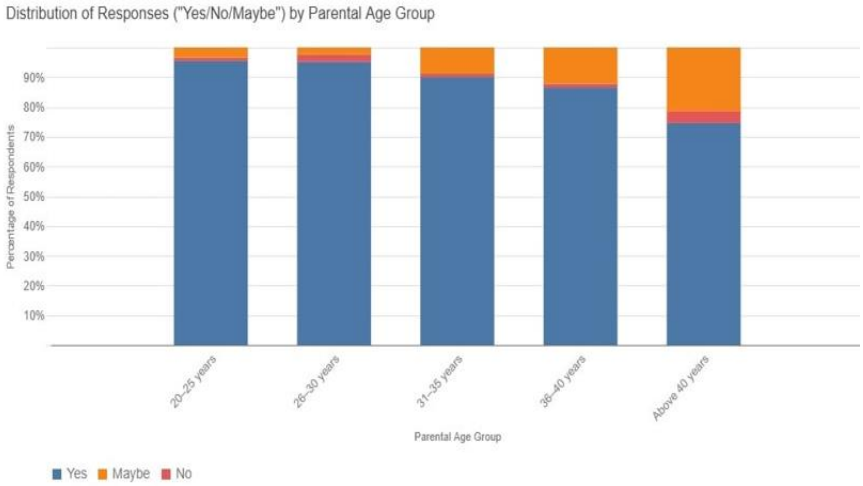

Figure 2: Association between parental age and belief in the effectiveness of AI tools

3.Association Between Parental Education and Oral Health Perception

A statistically significant association was observed between educational level and the importance attributed to oral health. Among the participants, 526 (73.8%) rated oral health as very important. The highest awareness was observed among parents with a Master's degree (83.9%), followed by Bachelor's degree holders (77.0%). Lower awareness was noted among Diploma (58.2%) and High-school educated parents (74.7%) (Fig 3).

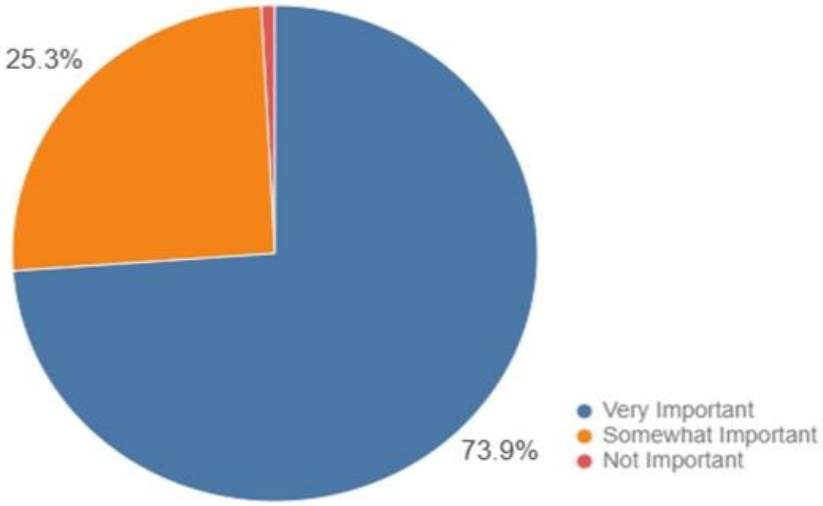

Figure 3: Educational level and the importance attributed to oral health

4. Association Between Parental Education and AI-Based Tool Awareness

Education level showed a significant association with preferred AI features ($\chi^2 = 66.584$, $p < 0.001$). The most preferred feature overall was integration with dental visits and follow-ups (48.0%), followed by progress tracking (26.3%) and daily reminders (25.4%). Parents with Bachelor's degrees demonstrated the highest preference for integration (69.0%) and progress tracking (55.6%) (Table 2).

Table 2: Association Between Parental Education and Desired AI Features for Oral Hygiene.

Highest Level of Education	Daily reminders for brushing & flossing	Educational content for children	Integration with dental visits & follow-ups	Progress reports on oral hygiene habits	N (Total)
High school	29 (16.0%)	8 (17.4%)	28 (35.4%)	14 (7.5%)	79 (100%)
Diploma	49 (27.1%)	3 (6.5%)	75 (45.5%)	37 (19.8%)	165 (100%)
Bachelor's degree	63 (34.8%)	15 (32.6%)	122 (69.0%)	104 (55.6%)	305 (100%)
Master's degree / Equivalent	40 (22.1%)	20 (43.5%)	71 (43.6%)	32 (17.1%)	163 (100%)
Total	181 (25.4%)	46 (6.5%)	296 (48.0%)	187 (26.3%)	712 (100%)

A statistically significant association was found between education and awareness of AI-powered oral hygiene tools ($\chi^2 = 39.805$, $p < 0.001$). Overall, 617 parents (86.7%) were aware of AI-based tools, with the highest awareness among Master's (88.9%) and Bachelor's degree holders (86.9%).

Similarly, belief in the efficacy of AI tools showed a strong association with educational level ($\chi^2 = 67.667$, $p < 0.001$). A total of 649 parents (91.2%) agreed that AI could improve oral hygiene practices, particularly those with Bachelor's (92.1%) and Master's (92.0%) qualifications (Table 3).

Table 3: It shows the association between education level and AI awareness/belief.

Highest Level of Education	Awareness of AI-Powered Oral Hygiene Tools			Belief in AI Efficacy for Oral Hygiene			N (Total)
	Yes	Maybe	No	Yes	Maybe	No	
High school	64 (81.0%)	7 (8.9%)	8 (10.1%)	68 (86.1%)	8 (10.1%)	3 (3.8%)	79 (100%)
Diploma	143 (86.7%)	10 (6.1%)	12 (7.3%)	150 (90.9%)	9 (5.5%)	6 (3.6%)	165 (100%)
Bachelor's degree	265 (86.9%)	14 (4.6%)	26 (8.5%)	281 (92.1%)	18 (5.9%)	6 (2.0%)	305 (100%)
Master's degree / Equivalent	145 (88.9%)	6 (3.7%)	12 (7.4%)	150 (92.0%)	10 (6.1%)	3 (1.8%)	163 (100%)
Total	617 (86.7%)	37 (5.2%)	58 (8.1%)	649 (91.2%)	45 (6.3%)	18 (2.5%)	712 (100%)

5. Non-Significant Associations

No statistically significant association was observed between parental education and type of toothbrush used (χ^2 = 27.068, p = 0.620). Additionally, no significant association was found between parental age or education and support for school-based oral health education programs (age: χ^2 = 11.127, p = 0.195; education: χ^2 = 6.109, p = 0.806).

DISCUSSION

In recent years, the integration of (AI) in dentistry has gained remarkable attention, especially in preventive and Pediatric care. The present study aimed to evaluate parental awareness of oral health and perception toward AI-powered oral hygiene tools (such as smart toothbrushes and dental apps) and how these parameters vary according to age and educational level among 712 parents of Gen z, Gen Alpha children.

Out of 712 respondents, 73.9% rated oral health as very important for their child's well-being, while 86.7% were aware of AI-powered tools such as smart toothbrushes and dental applications. Additionally, 91.2% believed that AI could enhance their child's oral hygiene maintenance. These findings reflect a positive and progressive attitude of parents toward AI-based oral healthcare.

A clear association was observed between educational level and awareness of oral health importance, with parents holding a Master's degree (83.9%) and Bachelor's degree (77.0%) showing higher awareness levels compared to those with Diploma (58.2%) or High school education (74.7%).

A significant association was found between parental age and belief in AI tools for improving oral-hygiene awareness (χ^2 = 39.593; p < 0.0001). Overall, 88.5%

of parents believed AI could enhance oral hygiene, with the highest confidence among younger parents aged 20–25 years (95.5%) and 26–30 years (95.2%). Belief declined with age, reaching 74.6% among those above 40 years, reflecting a generational gap in digital adaptability. These findings align with Celik et al. (2021) [4] and Gugnani et al. (2024) [5], who reported higher AI acceptance among younger, tech-aware parents.

Conversely, Petersen et al. (1995) [6] found limited oral-health awareness among older caregivers and teachers in Romania, where less than 40% had adequate oral health knowledge. This contrasts with our findings and reflects differences in digital exposure, accessibility and generational technology adaptation over time.

Studies by Jha & Arora (2020) [7] support the notion that digital learning environments positively impact cognitive and social adaptability among Gen Alpha children, indirectly implying that digitally active parents (aged 30–45 years) play a key role in encouraging the use of AI-assisted tools consistent with our data.

A significant association was observed between parental education and both awareness and belief in AI-powered oral-hygiene tools (Awareness: $\chi^2 = 39.805$; $p < 0.0001$; Belief: $\chi^2 = 67.667$; $p < 0.0001$). Among 712 respondents, 86.7% were aware and 91.2% believed in AI efficacy. Awareness was highest among parents with Master's (88.9%) and Bachelor's degrees (86.9%), indicating that higher education enhances digital literacy and acceptance of technology-based oral-health aids. These findings align with Winnier et al. (2015)[8] and Ayad et al. (2023)[9], who reported greater oral-health awareness and stronger acceptance of AI among educated individuals. Similarly, the Delta Dental Plans Association Report (2024)[10] noted that over 80% of parents valued their children's oral health and linked it to overall wellness, particularly among Millennials and Gen Z. These trends highlight a growing global shift toward integrating AI into pediatric oral-health routines.

However, Bahadir et al. (2024) [11] reported insufficient AI readiness among dental professionals in Turkey, contrasting with our findings. This disparity may reflect differences in accessibility, training, and socioeconomic context. Overall, age and education emerged as key determinants of AI awareness and belief, indicating a generational shift in digital health adaptability among younger, well-educated parents.

LIMITATIONS

The cross-sectional design of the study limits the ability to establish causal relationships. The online distribution of the questionnaire through Gmail and WhatsApp may have introduced selection bias toward digitally literate parents, potentially limiting generalizability, particularly among rural or lower socioeconomic populations.

Additionally, the study assessed self-reported awareness and perceptions rather than actual clinical behavior or long-term effectiveness of AI-based tools. The use of an English-only questionnaire may also have restricted participant diversity and introduced response bias.

CONCLUSION

The present study concludes that parental age and education significantly influence awareness and perception of AI-powered oral hygiene tools. Higher

awareness among educated and middle-aged parents reflects a growing digital transition in Pediatric oral-health practices. Compared with earlier research, the current findings indicate a notable increase in AI acceptance, suggesting that AI-driven oral-health programs, if integrated into parental education and community awareness initiatives, could substantially enhance preventive oral care in children.

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