

Mobile app for diagnosis of defects in enamel development: perception of interest of the dental Community

Talita Gabriella Alves Vieira¹  | Anieli Ferreira Nogueira²  | Paulo Antônio Martins-Júnior³ 
Marco Aurélio Benini Paschoal⁴ 

¹ Undergraduate student, Federal University of Minas Gerais – UFMG, Dental School, Belo Horizonte, Minas Gerais, Brazil.

² DDS, Post Graduate Program in Dentistry, Federal University of Minas Gerais – UFMG, Dental School, Belo Horizonte, Minas Gerais, Brazil.

³ DDS, MSc, PhD, Department of Child and Adolescent Oral Health, Federal University of Minas Gerais – UFMG, Dental School, Belo Horizonte, Minas Gerais, Brazil.

⁴ DDS, MSc, PhD, Centre for Rural Dentistry and Oral Health, School of Dentistry and Medical Sciences, Orange, New South Wales, Australia

Introduction: Developmental Defects of Enamel (DDEs) pose diagnostic challenges for dental professionals, potentially leading to inaccurate treatment plans. Mobile applications offer a promising tool to assist in clinical decision-making. Aim: This study aimed to assess the interest of the dental community (students and professionals) in a mobile application designed to aid in DDE diagnosis.

Material and Methods: A cross-sectional study was conducted using a convenience sample (n = 61) comprising undergraduate students, postgraduate students, clinicians, and professors in pediatric dentistry from Belo Horizonte, Brazil. Data collection took place over one month, beginning in November 2024, through a Google Forms questionnaire. Participants first viewed a video simulating the app's functionalities and then completed a virtual questionnaire assessing their knowledge of DDEs, diagnostic challenges, interest in the app, desired features, and willingness to pay.

Results: While most participants (73.8%) reported familiarity with DDE types, a significant proportion acknowledged difficulty in diagnosing them correctly (49.2% reported partial confidence), with distinguishing similar defects being the main challenge (75.4%). A total of 88.5% of participants considered the proposed application highly relevant, and 98.4% expressed interest in acquiring it. Willingness to pay was high (80.3%), with "Freemium" (37.7%) and "Single payment" (34.4%) being the preferred models. Suggestions for additional features were collected through open-ended responses. The responses were analyzed descriptively using absolute and relative frequencies.

Conclusion: The findings indicate significant interest in and perceived relevance of a DDE diagnostic mobile application within the dental community, supporting its development to enhance diagnostic accuracy and guide appropriate treatment.

Keywords: mobile applications; diagnosis, differential; developmental defects of enamel.

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INTRODUCTION

In Dentistry, accurate diagnostic skills are crucial, particularly for conditions like developmental enamel defects (DDEs). Identifying these defects early and precisely is fundamental not only for determining the

prognosis but also for formulating an effective, case-specific treatment and preventive plan, which are essential steps for successful management¹. Dentists are responsible for identifying and diagnosing changes in intraoral and extraoral structures. To achieve this, a thorough clinical examination involving a

Corresponding author:

Marco Aurélio Benini Paschoal
Marco Aurélio Benini Paschoal Centre for Rural Dentistry and Oral Health, School of Dentistry and Medical Sciences, Charles Sturt University, Leeds Parade, Orange NSW 2800, Australia.
E-mail: mpaschoal@csu.edu.au

detailed anamnesis, a physical examination to evaluate the entire stomatognathic system, and complementary exams must be conducted in an orderly and systematic manner².

Current evidence shows that the high prevalence rates of untreated caries in both deciduous and permanent dentitions constitute significant public health challenges, particularly in regions such as Latin America and the Caribbean³. Additionally, in some cases, the clinical consequences of caries disease can be exacerbated by the concomitant presence of developmental defects of enamel (DDEs), as these defects can be considered an additional risk for carious lesions in the primary dentition⁴.

These defects encompass alterations in the quality and/or quantity of this dental structure, presenting characteristics that can lead to significant clinical consequences. Teeth affected by DDEs, especially those with hypomineralization or hypoplasia, may exhibit a more porous, rough, and retentive surface, which facilitates dental biofilm accumulation and, consequently, increases susceptibility to dental caries⁵. The altered enamel structure itself, with lower mineral content or reduced thickness, may render it intrinsically less resistant to acid dissolution⁴⁻⁶. Additionally, the porosity of hypomineralized enamel, common in Molar-Incisor Hypomineralization (MIH), is frequently associated with dentin hypersensitivity, as it allows thermal or mechanical stimuli to more easily reach the dentin-pulp complex, causing pain and discomfort⁶⁻⁸.

Another relevant characteristic is the structural fragility and reduced mechanical resistance of this enamel, making it prone to post-eruptive breakdown (PEB), even under normal masticatory forces, resulting in the loss of dental structure and compromising function⁶⁻⁸. The combination of these clinical manifestations, including pain, functional difficulties (such as eating), and aesthetic concerns, can exert a substantial negative impact on the oral health-related quality of life (OHRQoL) of affected individuals⁹⁻¹².

Differential diagnosis is a key point on this subject since these defects can be easily confused with carious lesions, staining types, or other systemic conditions. Yet, an inappropriate diagnosis may favor an inaccurate treatment plan and unnecessary expenses⁴. The situation is further complicated because DDEs may present with wide clinical variability, with most defects seeming similar clinically, and even experienced professionals often show low levels of diagnostic

agreement, which can lead to inappropriate clinical approaches and providing inaccurate diagnoses for patients and their families as well¹³⁻¹⁵.

Nowadays, due to the advancement of technology and artificial intelligence (AI), mobile applications represent a feasible tool aimed at simplifying daily tasks in various fields of daily routine. Within dentistry, the application of information and communication technologies (ICTS) and mobile health solutions has already shown positive results, both in supporting clinical decision-making and in promoting evidence-based care¹⁶⁻²⁰. Studies also indicate good acceptance and usability among students and professionals, demonstrating their potential to improve diagnostic accuracy and efficiency²¹⁻²².

However, no validated mobile tools specifically focused on DDE diagnosis have been reported in the literature. This gap highlights the originality and importance of the present study, which investigates the interest of the dental community in the development of such an application. Thus, the objective of this investigation was to assess the interest of the dental community, including dental students, lecturers, and pediatric clinicians, in a mobile app designed to assist in diagnosing DDEs.

MATERIALS AND METHODS

This study was approved by the Human Research Ethics Committee of the Federal University of Minas Gerais (UFMG) (CAAE protocol 80567024.4.0000.5149). All the participants read and agreed to an informed consent form and a confidentiality agreement.

Study design and sample composition

This was a cross-sectional study conducted at the Federal University of Minas Gerais (UFMG) in Belo Horizonte, Brazil. A convenience sample (n = 61) was composed of undergraduate dental students, Master's/PhD's/specialist training professionals affiliated to Minas Gerais Association of Pediatric Dentistry (ABOPED-MG), professors of Pediatric Dentistry, and general practice professionals following a previously published study design and sample composition²³. The sample size was determined by convenience, based on the voluntary participation of all eligible individuals during a one-month data collection period (November - December 2024).

Eligibility criteria

Participants linked to the UFMG School of Dentistry (undergraduate students, postgraduate students, as well as professors) and the clinicians associated with the Brazilian Association of Pediatric Dentistry - Minas Gerais Region (ABOPED-MG) were included. There were no age restrictions, and clinical experience was not required for participation. Participants who did not accept the Free and Informed Consent Form or did not complete the questionnaire completely were excluded.

Definition of basic information and functionalities

A literature review was conducted to identify the main types of enamel defects, their histological and clinical characteristics, and the principal approaches and treatments. Additionally, a search for articles on the topic and similar applications in app stores (Android and iOS) was carried out to identify existing basic functionalities. This search identified functionalities such as image-based diagnostic aids, symptom checklists, and educational modules, which served as references for structuring the proposed tool^{20,21,23-30}.

Development of the App Prototype and Video Simulation

In this study, a Progressive Web App (PWA)¹⁶ was developed whose logic for diagnosing DDEs was structured based on a mind map designed on the Figma platform, under the supervision of postdoctoral professors in the field, and subsequently converted to JSON (JavaScript Object Notation) format, and deployed as a functional web application, active and accessible on the internet. However, participants did not directly access or use the prototype themselves. The decision to use PWA technology as a Proof of Concept (PoC) for this diagnostic tool is supported by the literature, which highlights the growing role of mobile technologies in health (m-Health)¹⁶⁻¹⁸. This choice was primarily due to the significantly lower initial investment compared to the development of separate native applications for Android and iOS¹⁶. Furthermore, the ease of access and updating, intrinsic characteristics of PWAs, combined with their well-defined logical structure, were crucial for allowing the rapid validation of interest in the tool and its diagnostic functionality within the scope of this

study. This PWA served as the basis for creating a video simulation demonstrating the intended functionalities presented to participants. The aim was to evaluate the perception and interest of the dental community in this preliminary version, thereby informing future investment in the development of the final application.

Data collection

A virtual questionnaire (*Google Forms*) was sent to all participants. Also, they were invited to watch the video simulating the mobile app functionalities described above. After watching the video, participants were asked to complete the virtual questionnaire with 16 multiple-choice questions and three open-ended questions. The multiple-choice questions were organized into four thematic blocks: (1) sociodemographic information; (2) academic background and professional experience in Pediatric Dentistry; (3) knowledge and diagnostic challenges related to DDEs; and (4) perception, interest, and willingness to pay for the proposed app. The open-ended questions explored (a) whether the participant knew or had previously tested any other mobile application for dental diagnosis, (b) suggestions for additional functionalities, and (c) general opinions about the tool. The questionnaire was developed by the authors for this study, and no pilot testing was performed.

Statistical analysis

Data (absolute and relative frequencies) were collected using the *Google Forms* platform and analyzed descriptively. Results for multiple-choice questions are presented as percentages, whereas open-ended responses were thematically categorized through joint analysis by two researchers, followed by discussion to achieve consensus on the final themes. Where no consensus was achieved, a third evaluator (with the highest degree) was claimed to give the final decision.

RESULTS

Age groups were categorized according to commonly used epidemiological criteria in dental research. A total of 61 participants responded to the questionnaire, with a predominance of participants aged between 20 and 30 years (41.0%), followed by participants over 51 years old (27.9%), those between 31 and 40 years old (16.4%), and those between 41 and 50 years old (14.7%).

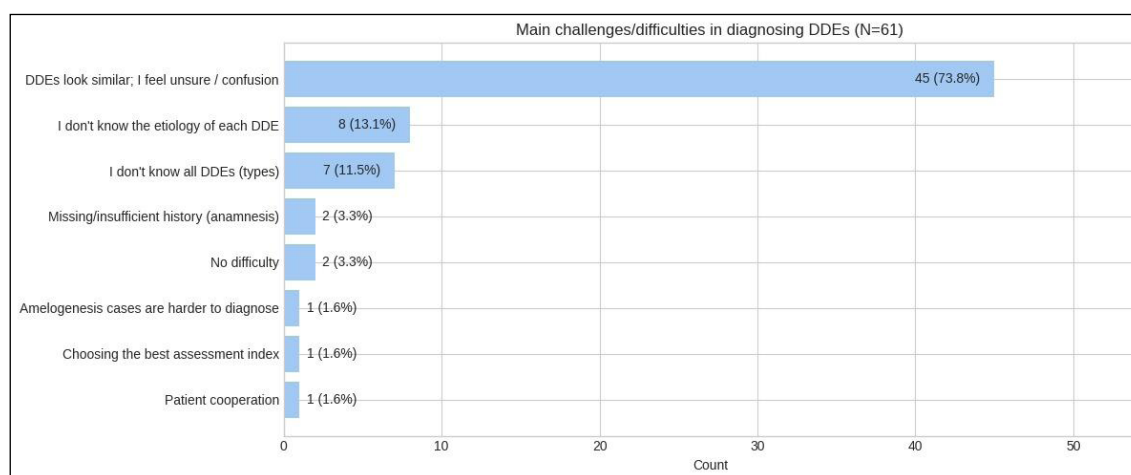
Regarding the professional level of the participants, 23% are pediatric dentistry professors, 21.3% are clinicians, 19.7% are postgraduate students in *lato sensu* programs, 18% are postgraduate students in *stricto sensu* programs, and 18% are undergraduate dental students. About the highest academic degree attained, 26.2% are specialists, 19.7% hold a completed undergraduate degree, 18% have not yet completed their undergraduate studies, 14.8% hold a Master's degree, 13.1% hold a Ph.D., and 8.2% have completed a postdoctoral program.

Concerning the length of experience in pediatric dentistry, 42.6% have been working in the field for more than 10 years, 26.2% have no experience, are still undergraduate students,

or are academic postgraduate students, 16.4% have between 1 and 3 years of experience, 9.8% have more than 5 and up to 10 years, and finally, 4.9% have between 4 and 5 years of experience.

The sample was asked about the knowledge and uncertainties regarding DDEs. Most people reported being familiar with the different types (73.8%), stated that they can recognize the other clinical features of these defects (59.0%), and affirmed their confident ability to diagnose DDEs properly (50.8%). Still, the most frequently reported clinical challenge was distinguishing between similar DDEs (73.8%), followed by etiology of each defect (13.1%), lack of knowledge about DDEs (11.5%), and other responses illustrated in Figure 1.

Figure 1. Main challenges/difficulties in diagnosing DDEs.

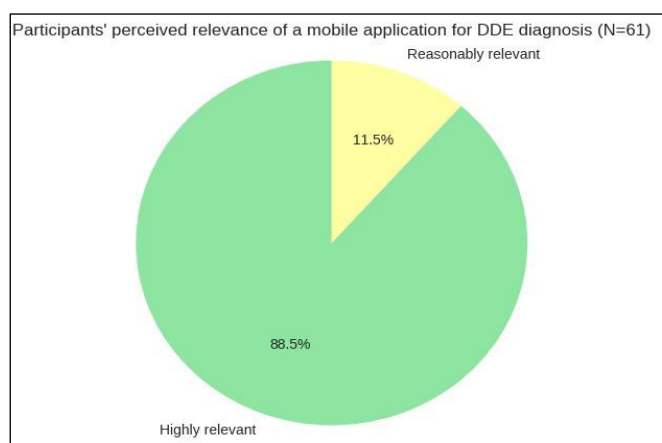


Source: Authors.

On the other hand, almost 80% stated they were confident in treating DDEs accordingly. Furthermore, in the open-ended question about previous knowledge or use of other dental diagnostic applications, only 3.3% of participants reported being aware of any such tools, mentioning one related to stomatology and another to endodontics.

After watching the demo video, 54 (88.5%) of 61 respondents rated it as highly relevant, expressing interest in acquiring the app (Figure 2). Some additional features were suggested by participants, including an option to generate a patient attendance spreadsheet and a section for questions, discussion, and exchanges with other professionals using the app.

Figure 2. Perceived Relevance of the application.



Source: Authors.

When asked about costs and payment options, the majority (80.3%) expressed willingness to pay for the application. Regarding the preferred payment model, the 'Freemium' option (free to try, paid to use) was the most popular (37.7%), followed closely by a 'Single payment' (34.4%). Yet, the reasonable price suggested was between USD 4 to USD 19* by 42.8%, and almost 80% of the respondents presented interest in being advised when the app was launched.

DISCUSSION

This study aimed to assess the knowledge of dental students and professionals regarding developmental enamel defects (DDEs) and their interest in an application designed to assist in the diagnosis of these conditions. Given the widespread adoption and portability of mobile devices, applications have become valuable tools for disseminating knowledge and relevant information¹⁹⁻²⁰. In dentistry, there are few applications available to aid in the diagnosis of specific conditions. In this study, only two participants (3.3%) reported being aware of any application that serves this purpose — one related to stomatology and another to endodontics. During the data collection process, fewer than ten applications for dental diagnosis were identified, and no application specifically designed for diagnosing DDEs was found. This observation is consistent with previous reports that highlight the scarcity of validated mobile health tools in dentistry^{17, 20, 24-30}.

The majority of participants in this study (75.4%) reported that their greatest challenge in diagnosing DDEs is the similarity between these defects. Additionally, nearly half of the study population (49.2%) can only partially diagnose DDEs. These findings confirm the difficulty dental professionals face in performing the differential diagnosis of these defects¹³, and may explain their low diagnostic accuracy¹⁴. Studies suggest this difficulty arises not only from overlapping clinical features between different DDEs and early caries but also potentially from varying familiarity with classification criteria or interpretation of subtle signs³¹.

This difficulty in accurate diagnosis is not merely an academic challenge; it carries significant consequences for both individuals and society. Misdiagnosing DDEs, often confusing them with caries or other conditions,

can lead to inappropriate, unnecessary, or delayed treatments. For instance, attempting to restore a hypomineralized molar as if it were a standard carious lesion may result in repeated restoration failures due to the compromised enamel structure³², leading to increased patient discomfort, higher costs, and potentially more invasive treatments down the line. Conversely, failing to recognize the specific needs of teeth with DDEs, such as managing hypersensitivity⁸ or preventing post-eruptive breakdown (PEB)⁴, can significantly impair the patient's oral health-related quality of life (OHRQoL), affecting eating, speaking, and psychosocial well-being¹⁰⁻¹². The cumulative effect includes higher long-term healthcare expenditures due to managing complications and retreatments, alongside the societal burden associated with reduced individual well-being and productivity.

Furthermore, diagnostic inaccuracy often stems from or leads to inadequate knowledge regarding appropriate treatment strategies for DDEs. As highlighted by the study's findings on diagnostic uncertainty, a lack of confidence in diagnosis naturally extends to treatment planning. Incorrect treatment plans may range from overly aggressive interventions, such as premature extractions, to inadequate management involving failure to address hypersensitivity⁸ or implement preventive measures against PEB⁴. This not only leads to suboptimal clinical outcomes but also represents inefficient use of healthcare resources, involving wasted materials, clinical time, and increased costs associated with managing failed or inappropriate treatments. Repeated ineffective interventions can also erode patient trust and potentially exacerbate dental anxiety¹⁰⁻¹². This fact underscores the need for a dedicated digital tool capable of supporting accurate diagnosis and guiding appropriate management of DDEs.

With their advanced technical capabilities, ease of access, and practicality, mobile applications serve as valuable tools that can enhance the quality of healthcare services¹⁶⁻¹⁸, reducing errors and increasing patient safety through decision-support systems¹⁹. The development of an application to assist in diagnosing DDEs was considered highly relevant by 88.5% of participants, and 98.4% expressed interest in obtaining the app. Furthermore, 80.3% indicated willingness to pay for it, with the majority (42.8%) willing to spend between approximately USD 4 and USD 19*, and the 'Freemium' model being regarded as the most appropriate payment

* Equivalent to the original range of R\$20.00 – R\$100.00 suggested by participants, based on an approximate exchange rate of 1 USD ≈ 5.4 BRL as of early 2025.

method. The additional features suggested by participants — such as a discussion forum and the possibility of generating patient attendance spreadsheets — represent opportunities to enhance the tool's interactivity, utility, and clinical relevance.

A major strength of this study lies in its innovative character, as it is one of the first initiatives to identify and report the absence of mobile applications specifically designed for the diagnosis of DDEs. By making this gap evident and documenting the interest of students and professionals, the study contributes novel evidence to the literature and provides the basis for developing solutions tailored to this diagnostic challenge.

The primary limitation of this study is the use of a convenience sample, which may introduce selection bias and limit generalizability, potentially leading to non-representative responses. However, despite this limitation, the results are promising and support the development of an application to assist in diagnosing developmental enamel defects, given the lack of similar apps and their innovative nature.

Finally, the application is currently at the prototype stage, functioning as an active and accessible web-based platform, although participants in this study evaluated it only through a video simulation. Future steps include (1) integrating the additional features suggested by participants, (2) conducting usability testing with students and professionals, (3) performing clinical validation studies to assess diagnostic accuracy and reproducibility, and (4) addressing regulatory and technical requirements for broader deployment. These stages are essential to ensure the final version of the app achieves reliability, safety, and acceptance in daily pediatric dentistry practice.

CONCLUSION

The introduction of an application to assist in the diagnosis of DDEs has generated interest and relevance among dentists, professionals, and students. The use of the application can help professionals and students increase their diagnostic accuracy about DDEs and consequently provide appropriate treatments to their patients. The app's applicability, safety, and practicality during dentistry care support its potential use and learning about the full versions of the app.

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AUTHOR CONTRIBUTION

Talita Gabriella Alves Vieira: Investigation, Data curation, Visualization, Writing & original draft. Anieli Ferreira Nogueira: Investigation, Data curation, Visualization, Writing & original draft. Paulo Antônio Martins-Júnior: Project administration, Conceptualization, Investigation, Data curation, Supervision, Writing, review & editing. Marco Aurélio Benini Paschoal: Project administration, Conceptualization, Investigation, Data curation, Supervision, Writing, review & editing.

CONFLICT OF INTERESTS

The mobile app is under development by the authors of this manuscript.

ORCID

Talita Gabriella Alves Vieira: <https://orcid.org/0009-0008-8199-6511>

Anieli Ferreira Nogueira: <https://orcid.org/0009-0007-0298-6255>

Paulo Antônio Martins-Júnior: <https://orcid.org/0000-0002-1575-5364>

Marco Aurélio Benini Paschoal: <https://orcid.org/0000-0002-3396-4688>

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