

Stefania MARTIGNON^(a) 
Andrea CORTES^(a) 
Viviana AVILA^(a) 
Karina VELASCO^(a) 
Ninoska ABREU-PLACERES^(b) 
Vicente ARANGUIZ^(c) 
Miriam BULLEN^(d) 
Rodrigo GIACAMAN^(e) 
Zilson MALHEIROS^(f) 
Amaury POZOS-GUILLÉN^(g) 
Fabio SAMPAIO^(h) 
Constanza Ella FERNÁNDEZ⁽ⁱ⁾ 
Mauricio GARCÍA^(j) 
Mónica GONZÁLEZ-MONTERO^(k) 
Sylvia GUDINO-FERNANDEZ^(l) 
Fernando Neves HUGO^(m) 
María Isabel PARDO-SILVA⁽ⁿ⁾ 
Lupe SALAZAR^(o) 
Aldo SQUASSI^(p) 
Olga Lucía ZARTA^(q) 
Bernal STEWART^(r) 
Sofía JÁCOME-LIÉVANO^(s) 

^(a)Universidad El Bosque, UNICA - Caries Research Unit, Research Department, Bogotá, Colombia.

^(b)Universidad Iberoamericana, Biomaterials and Dentistry Research Center, Research and Innovation Department, Santo Domingo, Dominican Republic.

^(c)Universidad de los Andes, Faculty of Dentistry, Cariology Unit, Santiago, Chile.

^(d)Panama University, Restorative Dentistry Department, Panama City, Panama.

^(e)University of Talca, Faculty of Dentistry, Cariology Unit, Talca, Chile.

^(f)Latin American Oral Health Association – LAOHA, São Paulo, SP, Brazil.

^(g)Universidad Autónoma de San Luis Potosí, Faculty of Dentistry, Basic Sciences Laboratory, San Luis Potosí, México.

^(h)Universidade Federal da Paraíba – UFPB, Health Science Center, Department of Clinical and Community Dentistry, João Pessoa, PB, Brazil.

⁽ⁱ⁾Federación Odontológica Colombiana – FOC, Bogotá, Colombia.

^(j)Fundación Universitaria CIEO - UniCIEO Posgrado de Rehabilitación Oral, Bogotá, Colombia.

^(k)Universidad de Costa Rica, Pediatric Dentistry Master Degree Program, San José, Costa Rica.

^(l)Universidade Federal do Rio Grande do Sul – UFRGS, Departamento de Odontologia Preventiva e Social, Porto Alegre, Brasil

^(m)Universidad El Bosque, Dental School, Bogotá, Colombia.

⁽ⁿ⁾Universidad de Panamá, Facultad de Odontología, Departamento de Clínica Integrada, Panama City, Panamá.

^(o)Universidad de Buenos Aires, Facultad de Odontología, Instituto de Investigaciones en Salud Pública, Buenos Aires, Argentina.

^(p)Universidad El Bosque, Dental School, Posgrado de Operación Estética y Materiales Dentales, Bogotá, Colombia.

^(q)Colgate-Palmolive Technology Center, Clinical Research, Piscataway, NJ, United States.

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Corresponding Author:
Stefania Martignon

E-mail: martignonstefania@unbosque.edu.co

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Core Cariology Curriculum Framework in Spanish for Latin American dental schools: development and consensus

Abstract: The aim of this study was to develop and achieve consensus on a cariology teaching framework for dental schools in Latin American Spanish-speaking countries. The Delphi process, with a $\geq 80\%$ pre-defined participants' agreement, included three phases and a Coordinating Group. During the Preparation phase three panels of experts were selected and invited to participate: a) Regional academic/professional Dental Associations (Associations-Panel): $n = 12$; b) Regional Dental Schools (Dental-Schools-Panel): existing dental schools ($n = 263$) from the 19 Spanish-speaking regional countries; c) International academic/professional associations Peer Experts (Peer-Panel): $n = 4$. Based on consensus documents from Europe, Colombia, the Caribbean, USA, Chile and Spain, and updated scientific evidence, the Coordinating Group developed a baseline framework proposal of domains, main competencies (MC) and specific competencies (SC). The Consultation-Agreement and Consensus phases included three rounds of questionnaires with a step-wise sharing of the MC updated version of the consensus framework with the Dental-Schools-Panel and including SC with the Associations-Panel. Diverse communication strategies were used (*e.g.*, independent google-form questionnaires and workshops). Consensus was reached after an on-site Associations-Panel workshop and secret voting, followed by an online meeting with the Peers-Panel. A total of 127 academic/professional institutions participated (Associations-Panel: 11, 91.6%; Dental-Schools-Panel: 112, 42.6%, all countries; Peers-Panel: 4, 100%). The baseline Cariology teaching framework of 5 domains, 10 MC and 92 SC underwent modifications after agreements for a final consensus framework consisting of 5 domains, 10 MC and 85 SC. A Core Cariology curriculum framework in Spanish for Latin American Dental Schools was successfully developed and agreed upon with regional dental academic and professional institutions.

Keywords: Education, Dental; Dental Caries; Curriculum; Competency-Based Education.

Introduction

Dental caries was defined in 2021 as 'a biofilm-mediated, diet modulated, multifactorial, non-communicable, dynamic disease resulting in net mineral loss of dental hard tissues', in the international



cariology terminology consensus report by ORCA (European Organisation for Caries Research) and CRG IADR (Cariology Research Group of IADR).¹ Despite the shift that the understanding of dental caries has undergone over the course of decades,²⁻⁴ and notwithstanding the available evidence-based, best-practice and cost-effective measures, untreated caries in permanent dentition continues to be the most common health condition that occurs in primary teeth in over 40% of children and it is associated with health inequalities.⁵⁻⁸

To change this global health scenario 'oral health has finally been included in the global agenda'.⁹ By reducing the prevalence of oral disease and promoting well-being through the course of life, and recognizing dental caries as a non-communicable disease, public health actions have been taken by the World Health Organization (WHO) and the World Dental Federation (FDI) to ensure progress towards universal health coverage for oral health by 2030.^{10,11} In parallel, a taskforce from the Alliance for a Cavity-Free Future (ACFF) delivered in 2021 a consensus of policy recommendations 'towards a more progressive and holistic long-term, patient-centered, tooth-preserving preventive care system, to reduce the incidence of dental cavities and to secure improvements in both oral and general health'.¹² Its first policy recommendation involves curriculum related changes. Simultaneously, experts from Latin America and the Caribbean, gathered together with support from the Latin American Oral Health Association (LAOHA)¹³ and reported on a regional review of caries-related epidemiology, quality of life, risk factors, prevention and management.¹⁴⁻¹⁸ From the latter, a general recommendation towards a stakeholders' regional oral health agenda was derived.¹⁹ This included three Call-to-action initiatives that were defined during the LAOHA online regional symposium-related, held the 14th of October 2021:²⁰ Fluoride use and sugar reduction policies in Latin America (1),²¹ and working on regional-level consensus documents for cariology teaching among dental schools for Spanish-speaking Latin American countries (2) and for Brazil (3).²² This paper focuses on the second Call to action.

Transformation of the cariology curriculum has been driven by the need to translate the caries paradigm shift into education and the practice, to move away from the curative approach shown in cariology teaching surveys in dental schools worldwide (*e.g.*, in Japan,²³ Europe,²⁴ Latin America,²⁵ Brazil,^{26,27} Chile,²⁸ Canada,²⁹ Australia with New Zealand³⁰ and Asian and Arabian countries³¹), towards a curricula where caries is considered a preventable disease that can be controlled through a patient-centered, risk-based caries management, with a focus on health outcomes to maintain oral health and preserve tooth structure in the long-term.³²

The European Core Curriculum in Cariology started the process in 2010 with the support from ORCA and the Association of Dental Education in Europe (ADEE).³³ Since then, adapted consensuses have been agreed upon by dental schools on a national-basis, such as in Colombia, with the Colombian Association of Dental Schools (ACFO, as per its Spanish acronym) and the Alliance for a Cavity Free Future (ACFF)³⁴ and in the USA, with the American Dental Education Association.³⁵ Other Spanish-speaking countries such as Chile, the Caribbean countries and Spain have followed.³⁶⁻³⁸ All documents follow the European core structure³³ and include five to six caries-driven domains related to knowledge base, assessment, synthesis, diagnosis and care - both at the individual level of caries risk and at the tooth-surface level of caries lesions, and by evidence-based cariology in clinical and public health practice.³³

The aim of this study was to develop and achieve consensus on a competency-based core cariology curriculum framework for use in dental schools in Latin American Spanish-speaking countries.

Methodology

This paper reports the process used to develop and achieve the cariology teaching consensus framework for dental schools in Latin American Spanish-speaking countries based on the previously mentioned frameworks,³³⁻³⁸ on best evidence and taking into consideration the regional context. The original language of the framework is Spanish,

applicable to Latin America, and its structure follows that of the European Core Curriculum,³³ in five Domains, each encompassing a minimum of one Main Competency (MC) supported by Specific Competencies (SC) with different levels of learning, as defined by Cowpe et al. (Table 1).³⁹ These, in a general way, are intended to cover the basic and fundamental aspects of cariology training, for use by educators, dental schools and countries, subject to national or internal adaptations.

Prior to the development and consensus of cariology, a survey and a hybrid workshop were held in November 2021 during the annual meeting of OFEDO-UDUAL (Organization of Dental Schools - Union of Latin American Universities). A total of n=121 (46%) deans participated, agreeing on a general curative approach within dental schools, and 91% manifested the will to participate in the development and consensus of a cariology curriculum framework for the region.

In order to conduct a thorough process of regional inclusivity and agreement, the Delphi process was used to establish the MC and SC to be considered, by using the nominal group method favored by consensus.⁴⁰ The process included three phases and was previously discussed and agreed upon by the LAOHA Cariology Core group. An agreement percentage of $\geq 80\%$ among participants was preset.

Preparation phase

Three panels and a coordinating group were selected: a panel inviting experts representing 12 regional academic and professional dental associations (Associations-Panel); a panel composed of representatives of the n = 263 dental schools in all Spanish-speaking Latin American 19 countries who accepted to participate (Dental Schools-Panel); a panel of expert peer reviewers willing to represent four international academic and professional associations (Peers-Panel), and a Coordinating Group of five experts and collaborators from UNICA (Caries Research Unit) at Universidad El Bosque. The Coordinating Group took into consideration the comparison of previous frameworks³³⁻³⁸ and updated scientific evidence, and produced a baseline framework proposal (Framework 1st version) by adapting the original five domains, the MC and their supporting SC.

Consultation and agreement phase.

This corresponded to a series of three rounds of questionnaire conducted to stabilize opinions. Although anonymity among participants' answers was maintained, later discussion was invited for achieving agreement. The coordinating group was in charge of controlling the feedback and updating the frameworks at each stage. In all rounds, each participant was asked to independently assess each

Table 1. Definitions of competencies and their levels of development (modified from Cowpe et al.).³⁹

Definitions of Competence
<i>Main Competency (MC)</i> , for this consensus, is conceived as the ability (including knowledge, skills and attitudes) of a dental student upon graduation to perform or provide a particular, complex service or job. Its complexity suggests that multiple and more specific skills (Specific or Supporting Competencies) are required to support the performance of any MC.
<i>Specific Competency (SC)</i> are specific or supporting skills, which can be considered subdivisions of a MC. The achievement of a MC requires the acquisition and demonstration of all the SCs related to that particular service or job. However, some SCs may also contribute to the achievement of other MCs.
Levels of Competency
<i>Be capable of:</i> A graduating dental student should demonstrate a theoretical knowledge and understanding of the subject matter, along with adequate clinical experience to be able to solve problems encountered in the clinic independently or without assistance.
<i>Have knowledge of:</i> A graduating dental student should demonstrate a solid theoretical knowledge and understanding of the subject matter, but may have limited clinical/practical experience.
<i>Be familiar with:</i> A graduating dental student should demonstrate an understanding of the subject matter, but need not have experience and is not expected to perform procedures or approaches independently.

item from the pedagogical and cariology perspective and define whether the MC or SC should or should not be included. A negative answer had to be supported by evidence and in case of a positive answer, conceptual and/or wording modifications could be proposed for both types of competencies, as well as changes in the level of development of learning for specific competencies.

The first round was conducted from February to April 2022, by sharing the baseline framework with the AP in two consecutive time intervals. It started with the 10 MC (including the five domains) and then continued with the SC. Each time, the document was shared via a Google Forms platform questionnaire (Google Inc., Menlo Park, United States of America) and this was followed by an online workshop that allowed for 'round table' discussions of controversial items until an agreement was achieved. Based on the agreements the CG produced a Framework 2nd version.

The second round was conducted by sharing the adapted 10 MC with the Dental Schools' panel via a Google Forms platform questionnaire. Up to three reminders were sent to the representatives and deans of dental schools who accepted to participate (May - August 2022). Answers went through discussion within the CG, who then produced a Framework 3rd version.

Consensus phase

The third and last round was conducted with the Associations' panel in a workshop held in Universidad El Bosque during September 2022. At this stage, the MC and SC were read out and the only available answering options were 'agree' or 'agree with modifications'; a secret voting was conducted with an electronic program (Turning Point interactive software, Ingesonic®). After the first voting, thorough "round table" discussions of items were held as and when required, either due to a lower-than-80% agreement or to different opinions about wording/concepts, and after their adaptation, agreement was confirmed by secretly voting for a second time. Subsequently, the Coordinating Group adapted the Framework 4th version, circulate it with the peer reviewers' panel and held an online meeting

with them for final agreements and recommendations about the document (October 2022). This resulted in the Framework 5th version and final cariology teaching consensus Framework for dental schools in Latin American Spanish-speaking countries.

Results

A total of 127 academic/professional institutions participated (Supplementary Table 2). These were distributed in $n = 11$ from the AP (91.6%) (ALOP -the Latin American Association of Pediatric Dentistry did not accept to participate); 112 dental schools (42.6%) from all (100%) Spanish-speaking countries in the DSP (see Table 3 for proportion of DS participation by country) and one additional English-speaking country DS from Trinidad and Tobago, and four associations in the EP (100%).

The baseline Framework 1st version included five Domains, 10 MC and 92 SC. The overall MC and SC agreement results after the first round (AP) corresponded to (mean; range): Full agreement (88%; 83–100%); Agreement with modifications (11%; 0–16%) and Disagreement (2%; 0–4%). After analysis of answers and modifications proposals, the CG derived a Framework 2nd version of 10 MC and 86 SC, applying wording modifications of Domains 1, 3 and 4, and content and wording modifications of seven and nine SC, respectively. Corresponding MC agreement results after the second round (DSP) disclosed: 92%; 87–96%; 8%; 4–13% and 0%, respectively. Wording adaptations were made in 29 MC for the Framework 3rd version. The third and on-site round (AP) reported high agreement results (mean; range) for MC (97%; 89–100%) and SC (99%; 89–100%). After discussions it was agreed to merge two SC of Domain 5 into one; to make content modifications in 18 SC, changing the learning level of one SC, making changes in the wording in three MC and 50 SC. Resulting Framework 4th version included five Domains, 10 MC and 85 SC. The suggestions from the PP were discussed and agreed, resulting in content modification of two MC and four SC, changing learning level in two SC, and changes in wording in Domains 3 and 4, 10 MC and two SC, for a final Cariology Core Curriculum Framework

Table 2. Academic/professional participating Institutions.

Panel	Country/Region	Name of institution
Panel of Regional Dental Academic or Professional Associations (D A/P A) (11/12 invited)	Colombia	ACODEB (Colombian Academy of Aesthetic Operative Dentistry and Biomaterials)
	Colombia	ACP (Colombian Academy of Prosthodontics)
	Latin America	ALODYB (Latin American Association of Operative Dentistry and Biomaterials)
	Colombia	FOC (Colombian Dental Federation)
	Latin America	FOLA (Latin American Dental Federation)
	Latin America	LAOHA Core Team (Latin American Oral Health Association) (n=9 participants)
	Latin America	LARO (Latin American Regional Organization)
	Latin America	IADR LAR (International Association for Dental Research-Latin American Region) - GLIOC (Elderly Group)
	Latin America	IADR LAR Caries Group (n=2 participants)
	Latin America	OFEDO/UDUAL (Organization of Dental Schools - Union of Latin American U.)
Panel of Peers: International D A/P A (4/4 invited)	Colombia	UNICA – Caries Research Unit, Universidad El Bosque (n=5 participants)
	The United States	AAC (American Academy of Cariology)
	International	FDI (World Dental Federation)
	International	IAPD (International Association of Pediatric Dentistry)
Dental Schools Panel (112/263 dental schools -DS invited, with participation of all 19 Spanish-speaking countries) and 1 English-speaking DS invited	International	ORCA (European Organisation for Caries Research) - Education Platform
	Argentina (9/20 DS)	Universidad Abierta Interamericana, Universidad Católica de Córdoba, Universidad Católica de La Plata Universidad de Buenos Aires, Universidad del Salvador, Universidad Nacional de Córdoba, Universidad Nacional de Río Negro, Universidad Nacional de Rosario, Universidad Nacional de Tucumán
	Bolivia (2/10 DS)	Universidad Privada Franz Tamayo-El Alto, Universidad Privada Franz Tamayo-Santa Cruz
	Chile (16/22 DS)	Pontificia Universidad Católica de Chile, Universidad Andrés Bello, Universidad Arturo Prat, Universidad Austral de Chile, Universidad Autónoma de Chile, Universidad de Antofagasta, Universidad de Alba-Pedro Valdivia, Universidad de Chile, Universidad de La Frontera, Universidad de La Serena, Universidad de Los Andes, Universidad de Talca, Universidad de Valparaíso, Universidad Mayor, Universidad San Sebastián, Universidad Viña del Mar
	Colombia (21/27 DS)	Corporación Universitario Rafael Núñez, Fundación Universidad del Norte, Fundación Universitaria San Martín, Institución Universitaria Colegios de Colombia-Bogotá, Pontificia Universidad Javeriana, Universidad Antonio Nariño, Universidad Autónoma de Manizales, Universidad CES, Universidad Cooperativa de Colombia (UCC)-Bogotá, UCC-Medellín, UCC-Pasto, UCC-Villavicencio, Universidad de Antioquia, Universidad de Cartagena, Universidad del Sinú-Cartagena, Universidad del Valle, Universidad El Bosque, Universidad Nacional de Colombia, Universidad Metropolitana, Universidad Santiago de Cali, Universidad Santo Tomas De Aquino
	Costa Rica (2/3 DS)	Universidad Latinoamericana de Ciencias y Tecnología, Universidad de Costa Rica
	Cuba (1/1 DS)	Universidad de La Habana
	Ecuador (5/16 DS)	Universidad Católica de Santiago de Guayaquil, Universidad de Los Hemisferios, Universidad Central del Ecuador, Universidad Regional Autónoma, Universidad San Gregorio de Portoviejo de Los Andes
	El Salvador (2/4 DS)	Universidad Evangélica de El Salvador, Universidad del Salvador
	Guatemala (1/3 DS)	Universidad De San Carlos de Guatemala
Honduras (2/3 DS)	Universidad Católica de Honduras-San Pedro Sula, Universidad Católica de Honduras-Tegucigalpa	

Continue

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	Mexico (23/ 81 DS)	Escuela Nacional de Estudios Superiores-Unidad León, Facultad de Estudios Superiores Zaragoza, Instituto Latinoamericano de Ciencias y Humanidades, Universidad Anáhuac, Universidad Autónoma de Campeche, Universidad Autónoma de Coahuila-Saltillo, Universidad Autónoma de Nayarit, Universidad Autónoma de Nuevo León, Universidad Autónoma de San Luis Potosí, Universidad Autónoma de Sinaloa, Universidad Autónoma de Yucatán, Universidad Autónoma de Zacatecas, Universidad Autónoma del Estado de México, Universidad Autónoma Metropolitana-Xochimilco, Universidad de La Salle Bajío, Universidad Latinoamericana-Campus Norte, Universidad Nacional Autónoma de México, Universidad Intercontinental, Universidad Popular Autónoma del Estado de Puebla, Universidad Regional del Sureste, Universidad Quetzalcóatl Irapuato, Universidad Veracruzana, Universidad Veracruzana-Río Blanco
Dental Schools Panel (112/263 dental schools -DS invited, with participation of all 19 Spanish-speaking countries) and 1 English-speaking DS invited	Nicaragua (1/3 DS)	Universidad Americana de Managua
	Panama (3/3 DS)	Universidad de Panamá, Universidad Latina, Universidad Interamericana de Panamá
	Paraguay (3/7 DS)	Universidad Autónoma del Paraguay Pierre Fauchard, Universidad Nacional de Asunción, Universidad Nacional de Concepción
	Peru (5/36 DS)	Universidad Católica Santo Toribio de Mogrovejo, Universidad Científica del Sur, Universidad de San Martín de Porres, Universidad Nacional Mayor de San Marcos, Universidad Peruana Cayetano Heredia
	Puerto Rico (1/1 DS)	Universidad de Puerto Rico
	Dominican Republic (6/13 DS)	Instituto Tecnológico de Santo Domingo, Universidad Católica Nordestana, Universidad Central del Este, Universidad Iberoamericana, Universidad Nacional Pedro Henríquez Ureña, Universidad Tecnológica de Santiago
	Uruguay (2/2 DS)	Universidad Católica de Uruguay, Universidad de La República de Uruguay
	Venezuela (7/8 DS)	Universidad Central de Venezuela, Universidad de Carabobo, Universidad de Los Andes, Universidad de Zulia, Universidad Gran Mariscal de Ayacucho, Universidad José Antonio Páez, Universidad Santa María
	Trinidad & Tobago (1/1)	The University of West Indies

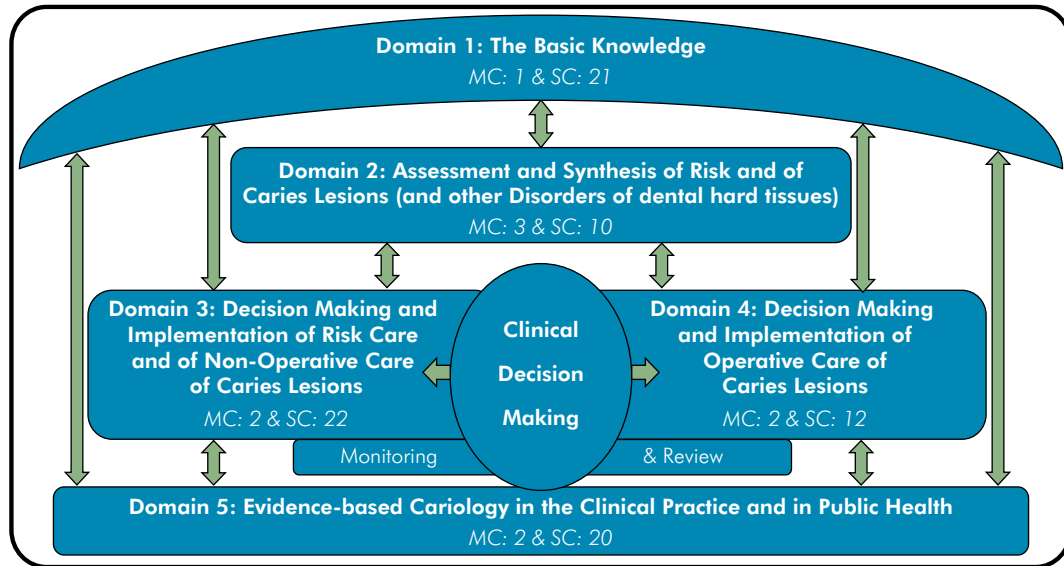
for Dental Schools in Latin American Spanish-speaking countries of five Domains, 10 MC and 85 SC. Figure shows the Cariology Framework general structure with Domain titles and respective number of MC and SC, illustrating the inter-relationship between domains. Table 3 shows the complete Cariology Framework.

A series of high-relevance general considerations were considered throughout the consensus process as common to all domains and competencies. These included:

- a. Aspects of social determination; life cycles/ life courses, with their particularities and differences, including their outcomes; emerging evidence; health promotion in a general context, including oral health; working in the context of the WHO and FDI 2030 emerging goals.^{10,11}
- b. In addition, the following considerations apply to clinical domains: Obtaining informed assent and/or consent; working with other members of the dental and health care team; critically

evaluating new scientific and technological developments and how to integrate them into their clinical activities; as regards to the term dental caries, this includes its classifications according to coronal/root location, if it is primary or secondary (associated with restorations and sealants - CARS), and in the primary (early childhood caries) or permanent dentition; other disorders of dental hard tissues (e.g., erosive tooth wear - associated with erosion, abrasion, attrition, abfraction, and developmental defects of the enamel, including but not limited to dental fluorosis, molar-incisor hypomineralization-MIH, hypomineralized second primary molar -HSPM, hypoplasia) are considered as part of the cariology teaching.³³⁻³⁸

- c. This consensus is of cariology and should be integrated with other clinical and systemic conditions related to oral health (such as periodontal disease, other dental, occlusal, articular conditions).



Adapted from Schulte et al.²²

Figure. General characteristics of the core cariology curriculum framework for dental schools in Latin American Spanish-speaking countries.

- d. It should be noted that each of the competencies (core and specific) should exist in the context of 'what for' and considering 'how it will be measured'.
- e. Terms used are in agreement with the dental caries terminology consensus report.¹

Discussion

This paper presents the process of development and consensus of the Core Cariology Curriculum Framework in Spanish for Latin American Dental Schools. This framework is based on European Core Cariology Curriculum³³ and those derived from it,³⁴⁻³⁸ and it takes into consideration the aspects of variability in education and context in the 19 Spanish-speaking Latin American countries. The development of this framework recognizes and respects the 'university autonomy' according to the Latin American Project of Convergence in Education (PLACEO, as per its Spanish acronym) seeking to offer "developing directives as model for the educational institutions, as well as the government and academic authorities, to make the modifications required to allow for adaptation of the existing educational systems in Dentistry, and would thus make it possible to achieve the standards of education of Dentists that our communities need".⁴¹

The comprehensive focus assumed for the domains and main competencies favored the approach of learning results of dentistry programs, as an explicit description of "what a student should know, understand, and be capable of performing, as the learning result".⁴² The resulting cariology curriculum framework had previously undergone regional and up-to-date adaptations related to content and wording, and it corresponded to a valuable dental education guideline in cariology within the region. After adapting the framework to local education systems, it is expected that its 10 Main Competencies will be followed, supported by the Specific Competencies. This framework offers precise parameters regarding cariology teaching and counts on being sufficiently flexible to allow for an independent implementation in each dental school.³⁵

The implementation of this cariology teaching framework poses a challenge to dental schools, in terms of infrastructure, budget, and curriculum components, including expected learning outcomes that reflect on the students' grading. Moreover, as Fontana et al. pointed out,³⁵ it requires educators' capability of teaching students to think critically and solve problems based on best available evidence. As an example of lack of evidence translated into clinical practice, we cite that in dental clinics, the

Table 3. Core cariology curriculum framework for dental schools in Latin American Spanish-speaking countries.

Domain I. The Knowledge Base		
This domain describes the basic knowledge necessary for domains II to V. A varying depth of knowledge and understanding of each aspect will be required in order to achieve the appropriate levels of competence.		
Main Competency 1.1		
Upon graduation, a dentistry student, should be capable of applying the knowledge and understanding of basic, biological, health, social, and applied sciences in clinical and collective practice, in order to recognize the process of dental caries and other alterations of hard dental tissues for decision making in health promotion, prevention and management of the disease in individuals and populations.		
Specific Competencies		
With regard to the development, growth and structure of relevant oral tissues, a dental student upon graduation should:		
<i>Have knowledge of:</i>		
1.1.1 The normal development, growth and structure of dental and oral tissues (e.g. dental hard tissues, pulp and salivary glands) at the macroscopic, microscopic and molecular levels.		
1.1.2 Developmental disorders of dental and oral tissues at the macroscopic, microscopic and molecular levels.		
With regard to the etiology, pathogenesis, and modifying factors of dental caries and other dental hard tissue disorders, a dental student upon graduation should:		
<i>Be capable of:</i>	<i>Have knowledge of:</i>	<i>Be familiar with:</i>
1.1.3 Describing and discussing the mechanisms and dynamic processes involved in the maintenance of health, as well as the response to dental caries and dental hard tissue alterations, at the macroscopic, microscopic and molecular levels.	1.1.6 Biochemical events in dental biofilm, saliva and dental hard tissues.	
1.1.4 Describing and discussing the role of dental biofilm, saliva, fluorides, diet and nutrition related to dental caries and other dental hard tissue disorders.	1.1.7 Microbiological events, including acid and base production and other biofilm metabolic processes associated with dental caries.	1.1.10 Individual risk assessment of other dental hard tissue disorders.
1.1.5 Describing and discussing the role of individual risk factors and social determinants related to dental caries and other dental hard tissue disorders.	1.1.8 The role of environmental factors, medications, and systemic diseases related to caries and other dental hard tissue disorders.	
	1.1.9 The different instruments for clinical assessment of individual caries risk.	
With regard to the identification/detection, assessment and synthesis/diagnosis in relation to caries risk and caries lesions, as well as other dental hard tissue alterations, a dental student upon graduation should:		
<i>Have knowledge of:</i>	<i>Be familiar with:</i>	
1.1.11 The physical, biochemical and biological basis of hard tissue changes related to the detection and assessment of dental caries and other dental hard tissue disorders.	1.1.15 The mode of action and limitations of emerging methods of detection, assessment and diagnosis of caries and other dental hard tissue disorders.	
1.1.12 The physical, biochemical and biological basis of methods of detecting and assessing dental caries and other dental hard tissue changes for diagnosis.		
1.1.13 The rationale for the operational characteristics to assess the validity and performance (sensitivity, specificity and predictive values) of detection, assessment and diagnostic methods for dental caries and other dental hard tissue disorders.		
1.1.14 The principles for assessing individual risk factors and social determinants related to risk for dental caries and other dental hard tissue disorders.		
With regard to behavioral sciences, a dental student upon graduation should:		
<i>Have knowledge of:</i>		
1.1.16 The psychological, sociological, and socioeconomic factors, which delineate interpersonal skills, communication, and behavior modification at the individual and group levels in relation to the management of dental caries and other dental hard tissue disorders.		
1.1.17 The principles of ethics, bioethics and professionalism in relation to the management of dental caries and other dental hard tissue disorders.		

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With regard to prevention and management, a dental student upon graduation should:

Have knowledge of:

1.1.18 The mode of action, composition, properties, limitations and side effects (local and/or systemic), of dental biomaterials, products and limitations and side effects of techniques, for the management of caries risk and the non-operative and operative management of caries and other dental hard tissue disorders, at the individual and collective level.

With regard to epidemiology and research methodology, a dental student upon graduation should:

Have knowledge of:

1.1.20 Basic concepts of epidemiology.

1.1.21 Research methodology, including study designs, sampling, bias control, and statistics, and their limitations.

Domain II: Assessment and Risk Synthesis and caries lesions (and other dental hard tissue disorders)

This domain refers to the assessment and diagnostic synthesis of caries risk and lesions and other dental hard tissue disorders. It represents a bridge between basic knowledge and decision making, preventive management (risk and non-operative) and operative management. It requires synthesis and evidence-informed and appropriate decision-making skills for clinical and public health practice. It also applies to other dental hard tissue disorders.

Main Competency 2.1

On graduation, the dentist must be capable of identifying individual risk factors and social determinants for caries (development/progression of caries lesions). The graduate should also have the ability to apply these skills to dental hard tissue disorders. An appropriate level of knowledge and understanding is required to reliably collect and record valid and clinically relevant data.

Specific Competencies

With regard to risk assessment, a dental student upon graduation should:

Be capable of:

2.1.1 Assess and record, individually and collectively, the presence of caries protective and risk factors (social, systemic, intraoral and behavioral), based on clinical history/anamnesis, interview and clinical examination, considering periodic reevaluation. It also applies to other dental hard tissue alterations.

Main Competency 2.2 - Detection and assessment of caries lesions and other dental hard tissue disorders.

Upon graduation, the dentist must be capable of collecting, based on visual/tactile and radiographic methods, data on the signs and symptoms of dental caries, detecting the experience (past occurrence) of dental caries, as well as the presence of caries lesions on tooth surfaces, assessing and categorizing their state of severity and their state of activity. Similar competence is required for the detection and assessment of other dental hard tissue disorders.

With regard to screening and assessment, a dental student upon graduation should:

Be capable of:

2.2.1 Recognizing abnormal dental tissue in primary and permanent dentition, differentiating between carious and non-carious lesions, as well as between primary and secondary coronal and root caries lesions.

2.2.2 Collecting and recording data on the presence of the caries process (detection) and assess its different stages of severity and its activity (related signs and symptoms).

2.2.3 Collecting and recording data on signs and symptoms of other dental hard tissue disorders, with emphasis on erosive tooth wear and developmental enamel defects such as dental fluorosis and hypomineralization of molar-incisor molars (HMI) or primary second molars (HSMP).

2.2.4 Appropriately use visual-tactile (with rounded tip probe support) and radiographic (coronal radiographs) diagnostic aids for dental caries, recognizing their operational characteristics and limitations. Visual diagnostic aids also apply to other dental hard tissue disorders.

Have knowledge of:

2.2.5 The operational characteristics and limitations of other diagnostic methods (e.g. fluorescence based) for caries and other dental hard tissue disorders.

Main Competency 2.3 - Synthesis and diagnosis of caries risk and lesions (and other dental hard tissue disorders)

Upon graduation, the dentist must be capable of synthesizing all relevant information contained in the clinical history by combining and interpreting individual/collective risk factors and caries findings, taking into account the patient's needs, preferences and interests, to decide the risk classification, severity and activity of caries lesions, establish a diagnosis and together with the patient, design a personalized management plan, including both follow-up and re-evaluation. The graduate should also be competent in applying these skills with respect to other dental hard tissue disorders. These aspects are linked to the clinical decision making reviewed in domains III and IV.

Continue

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Be capable of:

2.3.1 Comprehensively analyze caries risk data, obtained from individual/group assessment and existing monitoring, review or reassessment, to classify the risk, deciding together with the patient or guardian/group, considering their needs, preferences and interests, a health promotion plan, preventive management and reassessment intervals accordingly. It also applies to other dental hard tissue disorders.

2.3.2 Comprehensively analyze data on caries lesions, obtained from current assessment and existing monitoring, review or reassessment, to classify their severity and activity, deciding together with the patient/guardian, considering their needs, preferences and interests, an appropriate management plan, including control, non-operative management and operative management with preservation of tooth structure, as well as monitoring. It also applies to other dental hard tissue disorders.

2.3.3 Communicate to the patient/guardian or group the results of the caries risk assessment and the presence, severity and activity of caries lesions and other dental hard tissue disorders and provide recommendations that give them tools to control the pathology(ies) and improve their oral health.

2.3.4 Provide interdisciplinary consultation and management, or refer for specialist or medical diagnosis and management, in case of systemic conditions related to caries or unknown dental hard tissue disorders.

Domain III. Decision making and implementation of risk management and nonoperative caries lesions management

This domain is concerned with the individual/group management of risk and caries lesions and other dental hard tissue disorders (primarily erosive tooth wear and developmental enamel defects), with emphasis on planning, re-evaluation and long-term maintenance of risk management and non-operative management of caries lesions. This domain also includes communication with the patient (individual/group) as an essential part of the decision-making process.

Main Competency 3.1 - Patient, Family and Community Communication in Different Health Care Settings

Upon graduation, the dentist must be capable of communicating to patients of all ages, families and caregivers (or collectively), aspects of risk management and non-operative management of caries lesions, and other dental hard tissue disorders, in an effective, reflective and interactive manner. Communication should consider the age, socio-economic and cultural circumstances of the patient/families/caregivers/collective and the environment in which it takes place, strengthening autonomy and participation.

Specific Competencies

With regard to communication with the patient, family/caregivers and the collective, in different health care settings, a dental student upon graduation, should:

Be capable of:

3.1.1 Establishing an empathetic and mutually trusting relationship with the patient/family/caregivers/ collective.

3.1.2 Identifying and understanding and discussing the expectations, wishes, attitudes, needs and demands of the patient/family/caregivers/collective as inputs for promotional and preventive management planning.

3.1.3 Identifying and understanding the psychological, physical, socioeconomic and cultural factors that may influence patient/family/caregiver/collective adherence to the measures implemented for promotional and preventive management and their outcome.

3.1.4 Helping the patient/family/caregivers/group understand the importance of their role in the preventive management of dental caries, involving them to promote their understanding of the disease, to increase their adherence to individual/group preventive measures, and thus contribute to their future oral health. It also applies to other dental hard tissue disorders.

3.1.5 Providing appropriate and timely consultation/inter-consultation by exchanging patient/family/caregiver/collective information with other dental specialties and/or relevant health care professionals.

3.1.6 Assessing patient/family/caregiver/collective readiness to change and potential compliance with the proposed preventive management plan.

With regard to decision making and risk management and non-operative management of caries lesions, a dental student upon graduation, should:

Be capable of:

3.2.1 Making decisions based on synthesis (Domain II).

3.2.2 Developing health education actions directed to patients/families/caregivers/collective, relative to the etiology of dental hard tissue diseases and empower them to take responsibility for their oral health.

Have knowledge of:

3.1.7 Behavioral factors that facilitate the delivery of preventive management dental care.

3.1.8 Patient/family/caregiver/collective factors that influence communication and affect preventive management recommendations (e.g., expectations, time adherence, and manual dexterity).

3.1.9 Nonverbal communication skills; e.g., intonation, body language, sitting position, and eye contact.

3.1.10 Behavioral interventions; e.g., motivational interviewing, self-determination theory, and short behavior change tool.

3.1.11 The importance of patient/family/caregiver/collective recognition of the association between oral diseases and systemic diseases.

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3.2.3 Developing actions to promote healthy eating aimed at patients/families/caregivers/collective.

3.2.4 Developing actions to teach appropriate oral hygiene measures to patients/families/caregivers/collective.

3.2.5 Conducting professional prophylaxis.

3.2.6 Recognizing the mechanisms of action, limitations and adverse effects of self-applied and professionally applied individual/collective preventive management agents (e.g. fluorides, antimicrobials, calcium/arginine-based strategies, sealants), as well as their methods of administration/application.

3.2.7 Administering, prescribing or applying, preventive and/or therapeutic agents, when indicated, for risk management and non-operative management of caries lesions.

3.2.8 Monitoring the effects of mechanical and chemical control of dental biofilm, as well as the clinical status of sealants (assessing whether they need to be reapplied or repaired).

3.2.9 Polishing, adapt and/or repair dental biofilm retentive restorations that do not require replacement.

3.2.10 Considering the needs of people in vulnerable conditions, such as frailty, cognitive dependence or impairment, disabling conditions, systemic or psychiatric illnesses.

3.2.11 The role of diet and its association with the risk of developing caries and other dental hard tissue disorders.

Domain IV. Decision making and implementation of the operative management of caries lesions

This domain deals with the operative management of caries lesions and other alterations of dental hard tissues, with emphasis on their planning, maintenance and re-evaluation, accompanied by continuous preventive (risk and non-operative) management (Domain III). It involves applying the principles of tooth structure preservation. In addition, it is aligned with other fundamentals of dentistry: pediatric dentistry, restorative dentistry, endodontics, orthodontics, periodontics and prosthodontics, in terms of the execution of the restorative phase or an operative management plan for caries lesions. It is recognized that operative intervention should only be considered when non-operative (preventive) management options alone are no longer likely to be successful.

Main Competency 4.1 - Clinical decision making leading to operative management of caries lesions

Upon graduation, the dentist must be capable of collecting, interpreting and synthesizing all relevant information contained in the clinical history necessary to formulate appropriate operative management options that can be presented and agreed upon with the patient or guardian to decide on an individualized plan. This requires the ability to decide when it is appropriate to intervene operatively (in cavitational/cavitated caries lesions or those beyond the outer third of the dentin) and to know how to do so, understanding the consequences and prognosis of the decisions made. This applies to other dental hard tissue lesions.

Specific Competencies

With regard to clinical decision making leading to the operative management of caries lesions, a dental student upon graduation, should:

Be capable of:

4.1.1 Selecting the appropriate treatment option for each situation, based on the best available evidence from the full range of non-operative and operative management options available, and on the individual case.

4.1.2 Recognize, understand and manage the outcomes and consequences of operative intervention.

4.1.3 Conduct ongoing reflection on the decision-making process and management plan for operative interventions.

Have knowledge of:

4.1.4 The reactions of the dentin-pulp complex to the caries process and other dental hard tissue alterations and restorative procedures.

4.1.5 The success and failure rates of the different types of restorations.

Main Competency 4.2 - Operative management of caries lesions

Upon graduation, the dentist must be capable of using the operative management of caries lesions and other dental hard tissue alterations in an appropriate manner, with maximum preservation of dental structure, considering the restoration of dental tissue loss in form, function and esthetics, and simultaneously, promoting oral health. Additionally, the graduate should be able to systematically evaluate (at re-evaluation intervals and during management) all outcomes of operative management, and to adequately make decisions for maintenance, repair or replacement of a restoration, giving appropriate instructions to the patient or guardian, for its maintenance, as well as for the prevention of damage to their restorations and caries lesions associated with them.

Specific Competencies

With regard to the operative management of caries lesions and their re-evaluation and follow-up, a dental student upon graduation, should:

Continue

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Be capable of:

4.2.1 Deciding, prior to performing a restoration, taking into account the restorability of the tooth, when, how and how far to extend the removal of decayed tooth tissue (or other dental hard tissue alteration), seeking to achieve maximum preservation of tooth structure, maintain pulp and periodontal viability and generate functionality, to prolong tooth survival and increase the longevity of the restoration, consistent with the patient's comprehensive treatment plan.

4.2.2 Selecting and handling of the appropriate restorative biomaterials, considering their physical-mechanical and chemical properties, biocompatibility and longevity.

4.2.3 Selecting and performing appropriate operative techniques, both for the biomaterial and the case.

4.2.4 Identifying the response of operative procedures performed on the mucosa, pulpal organ-dentin, periodontal tissues, occlusion and function.

4.2.5 Evaluating and monitoring the outcomes (results) of operative management of caries lesions over time.

4.2.6 Establishing a maintenance schedule for the restoration, to prolong its longevity, and repair or replace when appropriate.

Have knowledge of:

4.2.7 Emerging techniques for the removal of carious tissue (e.g. step-by-step excavation) and for the management of other dental hard tissue disorders.

Domain V. Evidence-based cariology in clinical practice and public health

This domain addresses the core skills of evidence-based dental practice within the undergraduate curriculum, which includes the two phases of cariology, clinical (particularly related to individuals) and public health (particularly related to the collective). It should be noted that public health cariology requires additional competencies to those listed in domains II-IV. This domain relates to caries and other dental hard tissue disorders. The core competencies in evidence-based dentistry, which are generic to the undergraduate curriculum as a whole and not just cariology, are integrated with critical thinking and lifelong learning skills within dental practice. The clinical cariology competencies in caries assessment and management for the individual patient fall within domains II-IV, and for Public Health cariology, the competencies are presented within this domain, in close relation to the principles of evidence-based dentistry.

It is important for these topics to be recognized in the clinical and public health practice setting.

Main Competency 5.1 - Oral Public Health in Relation to Cariology

Upon graduation, the dentist must be capable of preventing and controlling dental caries and other dental hard tissue disorders, at a collective level. This requires an understanding of epidemiology, social determinants, health promotion and preventive strategies, the right to health, public policies, care systems and current regulations in oral health. It also requires an understanding of the interaction of these oral pathologies with other disorders, general health status and nutrition.

Specific Competencies

With regard to oral public health as it relates to cariology, a dental student upon graduation, should:

Be capable of:

5.1.1 Recording and interpreting dental caries and other dental hard tissue disorders at an epidemiological level.

5.1.2 Assessing oral health conditions, dental caries and dental hard tissue disorders in a community and their needs for care and attention.

5.1.3 Planning, implementing and evaluating jointly, with the corresponding entities and with patients or guardians, strategies for health promotion and prevention of dental caries and other dental hard tissue disorders and their relationship with other pathologies, at the individual and collective levels.

5.1.4 Analyzing population risk, considering social determinants and their relationship with the oral health situation and the burden of disease due to dental caries and other dental hard tissue disorders during the course of life, including identification of lifestyles, previous knowledge and social practices related to oral health, participating in the development of proposals to transform the situations found.

Have knowledge of:

5.1.5 The rights, duties and interests of individuals and health-related professionals, and the management of situations related to these.

5.1.6 The concept of quality of life related to general and oral health, with emphasis on dental caries and other alterations of dental hard tissues.

5.1.7 The interactions between dental caries and other health problems. Also applies to other dental hard tissue disorders.

5.1.8 Health promotion and prevention of oral disease in populations, with emphasis on caries and other dental hard tissue disorders.

Be familiar with:

5.1.11 Understanding health systems, their evolution at the global and national levels, and current regulations in relation to oral health.

5.1.12 Trends in oral health patterns and treatment needs.

5.1.13 International approaches to oral health care systems.

5.1.14 General health - economics aspects of the management of dental caries and other dental hard tissue disorders.

Continue

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	<p>5.1.9 The organization of oral health care and public health in their country, in accordance with the national health system and current regulations.</p> <p>5.1.10 The descriptive epidemiology of caries and other dental hard tissue disorders, in relation to different variables such as age, general health and social determinants.</p>
<p>Main Competency 5.2 - Evidence-based cariology</p> <p>Upon graduation, the dentist must be capable of developing an evidence-based practice to apply to the fields of dental caries, malformation injuries, traumatic injuries and other dental hard tissue disorders. This requires the ability to search for evidence of best clinical practices, make a critical appraisal, to select and apply in an informed manner the best available evidence.</p>	
<p>Specific Competencies</p> <p>With regard to dental caries and other evidence-based alterations of dental hard tissues, a dental student upon graduation. should:</p>	
<p><i>Be capable of:</i></p> <p>5.2.1 Identifying gaps in knowledge; formulate a structured clinical question that has a possible answer and search for evidence, using appropriate scientific resources (including biomedical research databases such as Pubmed, Cochrane, Scielo, etc.).</p> <p>5.2.2 Seek out and use the most appropriate current clinical management guidelines, recognizing their limitations.</p> <p>5.2.3 Critically analyzing the evidence on diagnostic methods and therapies to decide on their implementation, recognizing the existing methodological limitations.</p>	<p><i>Have knowledge of:</i></p> <p>5.2.4 The principles of evidence-based dentistry and the hierarchy of evidence.</p> <p>5.2.5 The transfer of evidence-based dentistry to clinical practice and public health, as well as to the individual and collective level.</p> <p>5.2.6 The principles of research methodology, including study design, bias control, representativeness, biostatistics, and extrapolation.</p>

requirements relative to evaluation have shown that they were traditionally focused on developing the ability to eliminate carious tissue completely, without considering a tooth-preserving approach.⁴³ In general, surveys on cariology teaching throughout the world have shown that the curative approach continues to be followed.²³⁻³¹

Considering that the future challenge is to translate the evidence (and guidelines, *e.g.*, this framework) into practice in order to render its real relevance,⁴⁴ work with implementation science⁴⁵ and support from the COM-B (capability, opportunity, motivation behavior model)⁴⁶ is on the way to start elucidating these aspects. For the moment this will occur on a small scale in eight Latin American Spanish-speaking dental schools. A survey (with COM-B) describing how dental students, educators and practitioners diagnose and manage caries in Colombia, after an overall moderate exposure of over 10 years to the ICCMS system (International Caries Classification and Management System), indicated that students perform many related up-to-date clinical behaviors with increasingly more significant frequency than educators and practitioners do.⁴⁷ The study also reported that best

clinical practices would more frequently translate into best clinical practices relative to diagnosis of risk and caries lesions, if resources (*e.g.*, time, oral health recording software) were increased. Moreover, caries management would also improve if the capability of the professionals and students related to these activities were also enhanced.

A limitation of this study was the low participation of dental schools in the area (42.6%). Although direct contact was made with OFEDO-UDUAL, and all 19 Spanish-speaking countries participated, there was a regional lack of an updated Latin American Spanish-speaking dental schools' directory. This could have occurred for many reasons, included the rapid and increasing number of dental schools in the region. For example, many of them have not yet become members of OFEDO-UDUAL and there were difficulties with online access; thus many showed no apparent interest in participating. Nevertheless, we now have a more updated directory that will enable us to offer future opportunities to participate in regional initiatives. This will be kept in the LAOHA repository and will be available by formal request.

The process of development and reaching consensus to achieve this framework was robust by

implementing the Delphi methodology⁴⁰ that was thoroughly and successfully followed. In the process, the academy was highly represented, evident by an important participation of dental schools - including all Spanish-speaking countries, and the participation of representatives of academic and professional associations that work closely with dental caries management and education.

There is increasing relevance of the implementation and adoption of this cariology teaching Framework by the academic community, given its contribution to the quality of education of future dentists, with the performance of evidence-based best clinical practices, in the context of the right to health, assuming ethical and social responsibility. Other aspects that will influence its implementation include the development of an oral health record that allows for registration of these updated aspects of cariology, in addition to being linked to a standardized software;⁴⁷ training and calibrating educators;³⁵ the shift of national health systems and health providers to payment systems focused on health outcomes⁴⁸ as well as shifting public and industry behavior to demonstrate the value of a cavity-free world.⁴⁶ Furthermore, the current relevance of caries

as a non-communicable disease,⁴ that has not only provided the opportunity of the disease being included in the WHO and FDI agendas.¹⁰⁻¹² Altogether, these aspects might influence the education area to recognize dental caries and cariology teaching at the same level and receiving emphasis equal to that laid on periodontal disease.⁴⁹

Conclusion

A Core Curriculum Framework in Cariology for Dental Schools in Latin American Spanish-speaking countries was successfully developed and agreed upon with regional dental academic and professional institutions.

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