UNIVERSIDAD AUTÓNOMA DE SAN LUIS POTOSÍ
FACULTAD DE ESTOMATOLOGÍA

DOCTORADO EN CIENCIAS ODONTOLÓGICAS

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SNP MMP 13, COMO BIOMARCADOR GENÉTICO DE CARIES DENTAL EN UNA POBLACIÓN ESCOLAR SALVADOREÑA.

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TESIS QUE PRESENTA:
WENDY YESENIA ESCOBAR DE GONZÁLEZ

PARA OBTENER EL GRADO DE:
DOCTORA EN CIENCIAS ODONTOLÓGICAS

DIRECTORA DE TESIS:
DRA. NURIA PATIÑO MARÍN

CO-DIRECTORA:
DRA. YOLANDA TERÁN FIGUEROA

SAN LUIS POTOSÍ, S.L.P. A 06 DE NOVIEMBRE DE 2024

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SINODALES:

Dra. Nereyda Niño Martínez (Presidenta) _____

Dra. Yolanda Terán Figueroa (Secretaria) _____

Dra. Nuria Patiño Marín (Vocal 1) _____

Dr. Marco Felipe Salas Orozco (Vocal 2) _____

SINODAL EXTERNO:

Dr. Jorge Alejandro Alegría Torres _____

AUTORIDADES:

Dra. Nuria Patiño Marín
Coordinadora del Doctorado _____

San Luis Potosí. S.L.P. 22 de octubre de 2024.

Los abajo firmantes miembros del comité evaluador después de una revisión cuidadosa del trabajo: **"SNP MMP 13, COMO BIOMARCADOR GENÉTICO DE CARIES DENTAL EN UNA POBLACIÓN ESCOLAR SALVADOREÑA"** de la alumna M.C. **Wendy Yesenia Escobar de González,** han determinado que el documento reúne los requisitos académicos para ser presentado y defendido en el examen de titulación para obtener el grado de Doctora en Ciencias Odontológicas otorgado por el Doctorado en Ciencias Odontológicas de la Universidad Autónoma de San Luis Potosí, México.

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SINODAL EXTERNO:

Dr. Jorge Alejandro Alegría Torres _____

DEDICATORIA

A mi mamá, Sonia Luz Amaya, mi motivación, a quien recuerdo todos los días.

RESUMEN

Antecedentes y objetivo: Los polimorfismos de las metaloproteinasas (MMP) tienen el potencial de ser probables biomarcadores genéticos de la caries dental y contribuir a identificar susceptibilidad a la enfermedad. El objetivo de este estudio fue evaluar la asociación entre la influencia de factores ambientales y el SNP MMP13 (rs2252070), con la experiencia de caries. **Materiales y métodos:** Se realizó un estudio transversal en 185 escolares salvadoreños de 7 a 12 años de edad. Se registraron variables sociodemográficas, frecuencia de cepillado dental, uso de seda dental y consumo de bebidas azucaradas. Se efectuó un examen clínico bucal para obtener los datos sobre caries. Se obtuvo ADN genómico a partir de células bucales de los niños. La genotipificación del polimorfismo se realizó mediante PCR-RFLP. Se compararon las frecuencias alélicas y genotípicas entre los grupos sanos y con caries. Los datos se analizaron con SPSS 26.0 mediante la prueba de chi-cuadrado y el análisis de regresión logística. **Resultados:** Los factores edad y presencia de placa dentobacteriana visible se asociaron significativamente con la experiencia de caries. Las frecuencias alélicas del polimorfismo MMP13-77 A/G fueron 0,7 y 0,3 siguiendo el equilibrio de Hardy Weinberg ($X2 = 0,22$, $p = 0,63$). No se encontraron diferencias significativas en las frecuencias alélicas y/o genotípicas del SNP de MMP13 (rs2252070) entre sujetos con caries dental y sujetos sanos ($p > 0,05$). **Conclusiones:** La variación genética seleccionada en MMP13 no se asoció con la experiencia de caries en sujetos seleccionados de El Salvador.

Palabras clave: Caries dental, Polimorfismos genéticos, Metaloproteinasa, MMP13.

LISTA DE PRODUCCIÓN ACADÉMICA

Cursos y Talleres

Otorga	Nombre del curso	Fecha	Estado / País
Universidad de El Salvador	Curso Virtual "Vamos a Publicar".	26, 28 y 29 de julio de 2021	San Salvador, El Salvador
Universidad de El Salvador	Curso Virtual "Ética y Epistemología en la Investigación Científica".	2 y 3 de septiembre de 2021	San Salvador, El Salvador
Universidad Autónoma de San Luis Potosí – Facultad de Estomatología	Curso "Bioética".	26 y 27 de octubre de 2021	San Luis Potosí, México
Wiley Online Library	Curso Virtual: "Introducción a la Biblioteca Cochrane".	12 de abril de 2022	Estados Unidos
Wiley Online Library	Curso: "Cochrane Library: Leveraging Systematic Reviews for Research".	21 de abril de 2022	Estados Unidos
Escuela de Posgrado, Facultad de Odontología, Universidad de El Salvador	Curso: "Investigación Básica en Periodoncia".	9 al 20 de mayo de 2022	San Salvador, El Salvador
Universidad de El Salvador	Curso: "Herramientas disponibles en el Sistema Bibliotecario".	6, 12, 15, 19 y 22 de julio	San Salvador, El Salvador
Ministerio de Educación de El Salvador	Certificación de Docentes en Educación Superior.	Del 24 de abril al 26 de mayo de 2023.	San Salvador, El Salvador
Laboratorio de Microbiología, Facultad de Enfermería y Nutrición, UASLP	Capacitación Experimental: "Montaje de Ensayo Taqman de Genotipado de SNP"	29 de agosto de 2023	San Luis Potosí, México
Laboratorio de Farmacología, Facultad de Ciencias Químicas, UASLP	Capacitación: "Presentación y análisis de resultados de SNP".	30 de agosto de 2023	San Luis Potosí, México
Laboratorio de Biología Molecular de la Coordinación para la Innovación y la Aplicación de la Ciencia y la Tecnología (CIACyT), UASLP	Capacitación Experimental: "PCR en tiempo real".	31 de agosto de 2023	San Luis Potosí, México
Organización Panamericana de la Salud	Curso Introductorio de Revisiones Sistemáticas de la Literatura.	Julio, 2024	OPS

Congresos Nacionales e Internacionales con Ponencia o Memorias

Otorga	Título de la ponencia	Autores	Nombre del Congreso	Fecha	Lugar país
Sociedad Nacional de Investigadores en Odontología y Universidad Autónoma de Yucatán	Práctica clínica odontológica en El Salvador y México durante la pandemia COVID-19. Análisis Transversal.	Wendy Yesenia Escobar de González, Marco Felipe Salas Orozco, Katleen Argentina Aguirre de Rodríguez, Nuria Patiño Marín, Guillermo Alfonso Aguirre, Escobar Gabriel Alejandro Martínez Castañón	XII Encuentro Nacional y XX Iberoamericano de Investigación en Odontología	17, 18 y 19 de noviembre de 2021	Yucatán, México
Universidad Autónoma de San Luis Potosí	Práctica clínica odontológica en El Salvador y México, durante la pandemia COVID-19.	Wendy Yesenia Escobar de González, Marco Felipe Salas Orozco, Katleen Argentina Aguirre de Rodríguez, Nuria Patiño Marín,	XXIX Congreso Internacional de Posgrado.	1, 2 y 3 de septiembre 2022	San Luís Potosí, México

		Guillermo Alfonso Aguirre Escobar, Gabriel Alejandro Martínez Castañón, Francisco José Rivas Cartagena			
Red de Investigación en Estomatología.	Práctica clínica odontológica en El Salvador y México, durante la pandemia COVID-19, análisis transversal.	Wendy Yesenia Escobar de González, Marco Felipe Salas Orozco, Katleen Argentina Aguirre de Rodríguez, Nuria Patiño Marín, Guillermo Alfonso Aguirre Escobar, Gabriel Alejandro Martínez Castañón, Francisco José Rivas Cartagena	3er Seminario de la Red de Investigación en Estomatología.	30 de nov, 1 y 2 de diciembre de 2022	Guadalajara, México
Red de Investigación en Estomatología.	Niveles de depresión en alumnos de odontología durante la pandemia COVID-19: México y El Salvador.	Isabel Alejandra Marín Hernández, Nuria Patiño Marín, Marco Felipe Salas Orosco, Wendy Yesenia Escobar de González, Raúl Márquez Preciado, Esthela Monserrat Torres Mendoza, Carlo Eduardo Medina Solís	3er Seminario de la Red de Investigación en Estomatología.	30 de nov, 1 y 2 de diciembre de 2022	Guadalajara, México
Universidad Autónoma de San Luis Potosí	Comparación de tres métodos para la detección de caries dental coronal.	Aguirre de Rodríguez Katleen Argentina, Gabriel Alejandro Martínez Castañón, Nereyda Niño Martínez, Castillo Hernández Jesús Ramón, Nuria Patiño Marín Castañeda de Abrego Vianney, Escobar de González Wendy Yesenia	XXX Congreso Internacional de Posgrados de la UASLP.	Agosto de 2023.	San Luis Potosí, México
Interdisciplinary Research on Advanced and Applied Chemistry	SNP MMP-13, como biomarcador genético de caries dental en población infantil salvadoreña.	Wendy Yesenia Escobar de González, Yolanda Terán Figueroa, Vianney Castañeda de Abrego, Nuria Patiño Marín, Nereyda Niño Martínez, Carlo Eduardo Medina Solís, Katleen Argentina Aguirre	1er Foro IRACh 2024.	8 y 11 de diciembre	San Luis Potosí, México
Red de Investigadores de Estomatología.	Método de extracción de ADN genómico de células	Wendy Yesenia Escobar de González,	4to Seminario de la Red de Investigadores de Estomatología.	Diciembre, 2024	Estado de Hidalgo, México

	bucales: Una propuesta para estudios epidemiológicos moleculares en escolares.	Nuria Patiño Marín, Yolanda Figueroa Terán, Carlo Eduardo Medina Solís, Nereyda Niño Martínez, Vianney Castañeda de Abrego, Katleen Argentina Aguirre de Rodríguez			
Universidad Autónoma de San Luis Potosí	Influencia Genética en la etiología de la caries dental.	Yolanda Figueroa Terán, Wendy Yesenia Escobar de González	Infociencia UASLP 2024.	Mayo 2024	San Luis Potosí, México

Asistencia en Congresos Nacionales e Internacionales sin Ponencia

Otorga	Nombre del Congreso	Fecha	Lugar país
Universidad Autónoma de San Luis Potosí	XVIII Congreso Internacional de Posgrados de UASLP	26, 27 y 28 de julio de 2021	San Luís Potosí, México
Universidad de El Salvador	IV Congreso Universitario de Investigaciones Científicas.	26, 27 y 28 de octubre de 2021	San Salvador, El Salvador
Sociedad Peruana de investigación Estomatológica	IV Congreso de Odontología Integral 2022	28 y 29 de mayo 2022	Lima, Perú
Universidad Autónoma de San Luis Potosí	XXIX Congreso Internacional de Posgrado.	1, 2 y 3 de septiembre 2022	San Luís Potosí, México
Universidad Autónoma de San Luis Potosí	Semana de Posgrado UASLP 2022	26 al 29 de septiembre de 2022	San Luís Potosí, México
Red de Investigación en Estomatología.	3er Seminario de la Red de Investigación en Estomatología.	30 de nov, 1 y 2 de diciembre de 2022	Guadalajara, México
Red de Investigación en Estomatología.	3er Seminario de la Red de Investigación en Estomatología.	30 de nov, 1 y 2 de diciembre de 2022	Guadalajara, México
Universidad Autónoma de San Luis Potosí	XXX Congreso Internacional de Posgrados de la UASLP.	Agosto de 2023.	San Luis Potosí, México

Premios o Distinciones

Otorga	Autores	Título de la ponencia	Nombre del Congreso	Lugar /País/ Estado
Sociedad Nacional de Investigadores en Odontología y Universidad Autónoma de Yucatán	Wendy Yesenia Escobar de González, Nuria Patiño Marín, Yolanda Figueroa Terán, Carlo Eduardo Medina Solís, Nereyda Niño Martínez, Vianney Castañeda de Abrego, Katleen Argentina	Práctica clínica odontológica en El Salvador y México durante la pandemia COVID-19. Análisis Transversal (Primer Lugar, Categoría: Doctorado, Epidemiología)	Encuentro Nacional y XX Iberoamericano de Investigación en Odontología	Yucatán, México, 2021

	Aguirre de Rodríguez			
Red de Investigación en Estomatología.	Isabel Alejandra Marín Hernández, Nuria Patiño Marín, Marco Felipe Salas Orosco, Wendy Yesenia Escobar de González, Raúl Márquez Preciado, Esthela Monserrat Torres Mendoza, Carlo Eduardo Medina Solís	Niveles de depresión en alumnos de odontología durante la pandemia COVID-19: México y El Salvador (Primer Lugar, Categoría: Licenciatura).	3er Seminario de la Red de Investigación en Estomatología.	Guadalajara, México, 2022
Red de Investigación en Estomatología.	Wendy Yesenia Escobar de González, Nuria Patiño Marín, Yolanda Figueroa Terán, Carlo Eduardo Medina Solís, Nereyda Niño Martínez, Vianney Castañeda de Abrego, Katleen Argentina Aguirre de Rodríguez	Método de extracción de ADN genómico de células bucales: Una propuesta para estudios epidemiológicos moleculares en escolares (Tercer Lugar, Categoría: Doctorado).	4to Seminario de la Red de Investigadores de Estomatología	Estado de Hidalgo, México, 2023

Publicación de artículos científicos

Nombre de la publicación	Revista (IF)	Manuscrip ID	Estado
Method of DNA Extraction from buccal cells: A proposal for genetic epidemiological studies in schoolchildren.	Cureus (1.2)	-	Enviado
Role of the MMP13 (−77A>G) polymorphism in Salvadoran children with caries	Archives of Medical Research (4.7)	AMS-17746-2024-01	Enviado
Effect of the combined application of silver nanoparticles of chitosan gel on dental enamel remineralization: an in vitro study.	Plos One (2.9)	PONE-D-24-18265	Enviado
Depression and opinion of dental students regarding the hybrid learning model during the COVID-19 pandemic.	BMC Psychology (2.7)	https://doi.org/10.1186/s40359-023-01157-8	Publicado
Impact of COVID-19 on Dental Practices in El Salvador and Mexico: A Comprehensive Survey Analysis.	Cureus (1.2)	https://doi.org/10.7759/cureus.46524	Publicado
Vigilancia Epidemiológica de Covid-19 en Estudiantes de Odontología de la Universidad de El Salvador	Minerva	https://doi.org/10.5377/revminerva.v5i3.15914	Publicado
Causas principales de extracción de órganos dentales donados al biobanco de la Facultad de Odontología de la	Minerva	https://doi.org/10.5377/revminerva.v5i3.15811	Publicado

Universidad de El Salvador, 2019			
Efectividad de intervención integral para prevención y tratamiento de caries dental, en escolares salvadoreños. Minerva 2022	Minerva	https://doi.org/10.5377/revminerva.v5i3.15812	Publicado
Comparación de la efectividad en la remineralización de la Lesión Inicial de Caries Dental utilizando dos protocolos de aplicación y dos marcas de Flúor Barniz al 5%	Minerva	https://doi.org/10.5377/revminerva.v5i3.15820	Publicado
Técnica de resina inyectada en paciente psicosocialmente afectada por presencia de diastema: Reporte de caso	Minerva	https://doi.org/10.5377/revminerva.v5i3.15821	Publicado
Impacto en la odontología por COVID-19 en El Salvador.	Minerva	https://doi.org/10.5377/revminerva.v5i3.15822	Publicado
Bio-Banco de Órganos Dentales de la Facultad de Odontología, Universidad de El Salvador	Minerva	https://doi.org/10.5377/revminerva.v5i3.15823	Publicado

Memorias de Congresos

Título del Trabajo	Nombre del congreso	Estado
Práctica clínica odontológica en El Salvador y México, durante la pandemia COVID-19. Análisis Transversal.	XXIX Congreso Internacional de Posgrado	Publicado
Comparación de tres métodos para la detección de caries dental coronal incipiente. estudio in vitro.	XXX Congreso Internacional de Posgrados, 2023	Publicado

Retribución Social

Tipo de participación	Institución	Dirigido a	Fecha
Coordinadora Ad-Honorem de los procesos de grado de la Facultad de Odontología de la Universidad de El Salvador	Facultad de Odontología, Universidad de El Salvador	Egresados del Doctorado en Cirugía Dental	2021-2023

ÍNDICE

1. INTRODUCCIÓN

Actualmente, la caries dental sigue siendo un importante problema de salud pública pese a la implementación de diversas medidas de prevención. Según la Organización Mundial de la Salud (OMS), afecta al 60-90% de los niños en edad escolar, así como a un gran número de adultos [1]. Específicamente en El Salvador, el 93% de los niños de 12 años de edad padecen caries dental, con una experiencia promedio según CPOD/ceod de 7.16 [2]. Dicho contexto es preocupante, por cuanto la caries es causa de dolor y pérdida de dientes y particularmente en niños, es relacionada a problemas de aprendizaje, comer o dormir [3].

Dada su naturaleza multifactorial, el proceso de la caries es influenciado por factores biológicos, conductuales, psicosociales y ambientales [4]. Sin embargo, se ha encontrado que sujetos sometidos a los mismos factores de riesgo y de protección, podrían presentar diferencias en el desarrollo y severidad de la enfermedad [5]. En tal sentido, la evidencia reciente sugiere que los estudios genéticos pueden contribuir a una mejor comprensión de la susceptibilidad individual y ser la base para el desarrollo de estrategias preventivas y terapéuticas más eficientes [6,7].

Estudios realizados han informado que variaciones genéticas en enzimas tales como las metaloproteínasas (MMP) pueden influir en la susceptibilidad de los individuos a desarrollar caries [8–10]. Las MMP son enzimas reguladoras principales del recambio de matriz extracelular y juegan un papel importante en la organización de la matriz orgánica del esmalte y la dentina, de ahí que se sugiere la participación de sus variantes genéticas en el control y la progresión de la caries, específicamente, de los polimorfismos de un solo nucleótido (SNP, por sus siglas en inglés) [11–13].

Entre los miembros de la familia multigénica de las metaloproteinasas, la variación genética de la MMP13 ha sido una de las más estudiadas en relación con la caries [14]. Se denomina colagenasa-3 porque degrada los componentes de la matriz extracelular como colágenos, gelatina, perlecan y fibronectina [15]. La MMP13 se expresa durante el desarrollo dental y está implicada en el desarrollo y la reparación

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ósea [16]. Se ha informado que la expresión de MMP13 aumenta en el tejido dental con la progresión de la caries [17,18].

Un polimorfismo funcional en el gen MMP13 es el MMP13-77A/G (rs2252070), que se ha asociado con la experiencia de caries en otras poblaciones [23,24]. El objetivo del presente estudio fue determinar la asociación de MMP13-77A/G (rs2252070) con caries dental y explorar la contribución de variables sociodemográficas, placa dentobacteriana y hábitos de higiene oral en una población de niños salvadoreños de 7 a 12 años de edad.

2. MATERIALES Y MÉTODOS

Población de estudio

Este estudio fue aprobado por el Comité de Ética de la Facultad de Odontología de la Universidad de El Salvador bajo el protocolo número 2022-012 y se cumplieron los principios de la Declaración de Helsinki. Se obtuvo el consentimiento informado de los padres o tutores y el asentimiento de los sujetos de estudio.

Se realizó el cálculo muestral en la calculadora en línea granmo, aceptando un riesgo alfa de 0.05 y un riesgo beta inferior al 0.2 en un contraste bilateral, se determinó que se necesitaría un mínimo de 173 sujetos para detectar una diferencia igual o superior a 0.1 unidades. Se asumió que la proporción en el grupo de referencia sería de 0.7.

Se incluyeron escolares salvadoreños sanos de 7-12 años de edad, no estaban emparentados, sin antecedentes médicos relevantes y no estaban en tratamiento con antibióticos. Todos los padres o tutores respondieron a un cuestionario sobre la frecuencia del cepillado dental, uso de seda dental y consumo de bebidas azucaradas de los niños.

Determinación de la experiencia de caries

El examen intraoral fue realizado por el mismo dentista, mediante criterios visuales, utilizando una sonda y un espejo dental estériles por cada sujeto. Las puntuaciones de placa dental se registraron según Silness y Löe [19]. La experiencia de caries se evaluó mediante los índices de dientes cariados, ausentes y obturados CPOD y/o ceod siguiendo las recomendaciones de la OMS [20]. Los niños se dividieron en dos grupos: sanos (sujetos con ceod/CPOD = 0) y con caries (ceod/CPOD≥1).

Determinación genotípica

El ADN genómico para el análisis molecular se extrajo a partir de células bucales de las caras internas de las mejillas de cada niño, según el método modificado descrito Mulot [21].

El SNP en MMP13 se analizó mediante análisis de polimorfismo de longitud de fragmentos de restricción basado en PCR (PCR-RFLP). Los cebadores utilizados para la amplificación de la región promotora específica que contiene el sitio MMP13 -77A/G fueron 5´-GATACGTTCTTACAGAAGGC-3´ (hacia delante) y 5´-GACAAATCATCTTCATCACC-3´ (inverso) [22]. Las muestras de ADN genómico de cada sujeto se mezclaron en una reacción con un volumen final de 25 µl que contenía 12.5 µl de GoTaq® Green Master (Promega, USA), 1 µl de 10 µM de cada cebador específico, 2 µl de cada muestra de ADN genómico y 8.5 µl de agua ultra pura libre de endonucleasas. Las condiciones de PCR fueron: un paso inicial de desnaturalización a 94° C durante 5 min, 35 ciclos de 94 ∘C durante 1 min, 55 °C durante 1 min, 72 °C durante 1 min y un paso final de extensión a 72 ∘C durante 5 min. Posteriormente, 5 µl de cada producto de PCR fue digerido con la enzima de restricción específica Bsr I (New England Biolabs, Inc.) durante 2 h a 65 ∘C según las instrucciones del fabricante. Los productos se analizaron en geles de agarosa al 2%, con 0.5 µl de GelRed (Biotium, USA). El homocigoto GG produjo dos bandas de 248 pb y 197 pb, el heterocigoto AG produjo tres bandas: 445, 248 y 197 pb, y el homocigoto AA produjo una única banda de 445 pb.

Análisis estadístico

LoCPODs análisis estadísticos se realizaron en el paquete estadístico SPSS, versión 26.0 (SPSS Inc., Chicago, IL, EE.UU.). Se aplicó la prueba X^2 del equilibrio de Hardy-Weinberg para determinar la diferencia entre las frecuencias genotípicas observadas y esperadas a partir de las frecuencias alélicas. Se utilizaron la prueba U de Mann-Whitney y la prueba X^2 para analizar la edad, sexo y hábitos preventivos entre el grupo con experiencia de caries y el grupo sin caries. Un análisis de regresión logística binaria se realizó para evaluar la influencia de las variables en la experiencia de caries. Un valor $p < 0,05$ se consideró significativo.

3. RESULTADOS

De un total de 185 sujetos participantes del estudio, la edad media fue de 10,43 ± 1,43 años. El 53% eran del sexo femenino y el 47% del sexo masculino. Las medias de CPOD y ceod fueron de 1,19 ± 1,54 y 2,11 ± 2,56, respectivamente. El 61% de los escolares presentaron experiencia de caries dental y el 39% estaban sanos.

Los factores edad y presencia de placadentobacteriana visible se asociaron significativamente con la experiencia de caries (Tabla 1).

La distribución de las frecuencias genotípicas en la población del estudio para MMP13-77 A/G fue del 50% homocigoto AA, del 40% heterocigoto AG y 10% homocigoto GG. Los genotipos analizados se encontraron en Hardy– Weinberg equilibrium: $X^2 = 0.22$, $p = 0.63$. No mostraron diferencias entre sanos y cariados (Gráficos 1 y 2).

Cuando en la regresión logística binaria se analizó la influencia del polimorfismo MMP13-77 A/G y las prácticas de higiene oral en la experiencia de caries dental, únicamente la presencia de placa dentobacteriana, mostró una asociación significativa (Tabla 2).

Tabla 1. Variables sociodemográficas y hábitos de higiene dental de los participantes en el estudio asociada a la experiencia de caries dental.

Variables		Niños con experiencia de caries (n=113)	Sanos (n=72)	*p*-valor
Edad (media ± DS)		10.26 ± 1.52	10.71 ± 1.23	**0.03***
Sexo n (%)	Masculino	53 (28.6)	34 (18.4)	0.96
	Femenino	60 (32.4)	38 (20.6)	
Frecuencia de Cepillado Dental n (%)	3 veces al día	27 (14.6)	17 (9.2)	0.97
	2 veces al día	67 (36.2)	42 (22.7)	
	1 vez al día	19 (10.3)	13 (7)	
Uso de seda dental n (%)	Sí	6 (3.3)	7 (3.8)	0.25
	No	107 (57.8)	65 (35.1)	
Consumo semanal de bebidas azucaradas n (%)	1-3 veces	70 (37.8)	47 (25.4)	0.64
	4 o más veces	43 (23.3)	25 (13.5)	
Placa Dentobacteriana n (%)	No visible	93 (50.3)	67 (36.2)	**0.03***
	Visible	20 (10.8)	5 (2.7)	

*$p < 0.05$, Estadísticamente significativo; OR (95% CI) = Odds ratio; 95% intervalos de confianza

Gráfico 1. Distribución alélica del polimorfismo MMP13-77 A/G de acuerdo a la experiencia en caries.
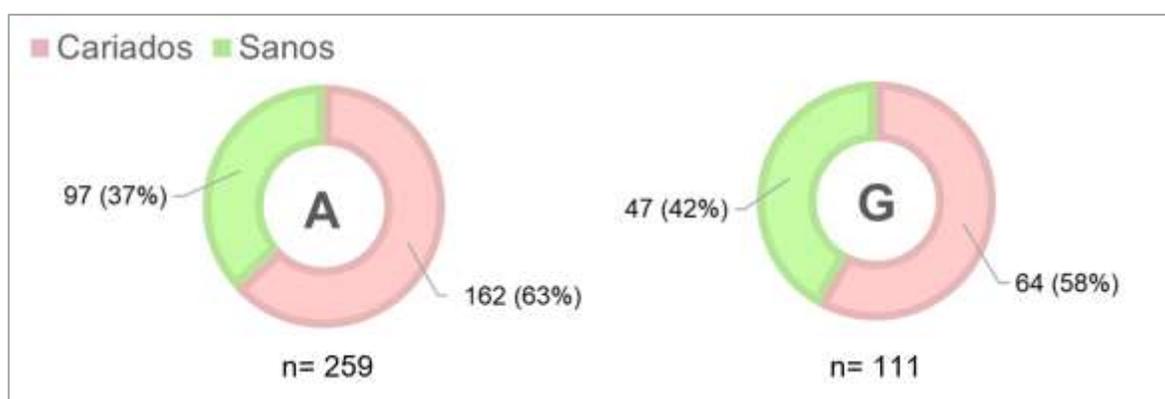
X^2 valor p= 0.37

Gráfico 2. Distribución genotípica del polimorfismo MMP13-77 A/G de acuerdo a la experiencia en caries.
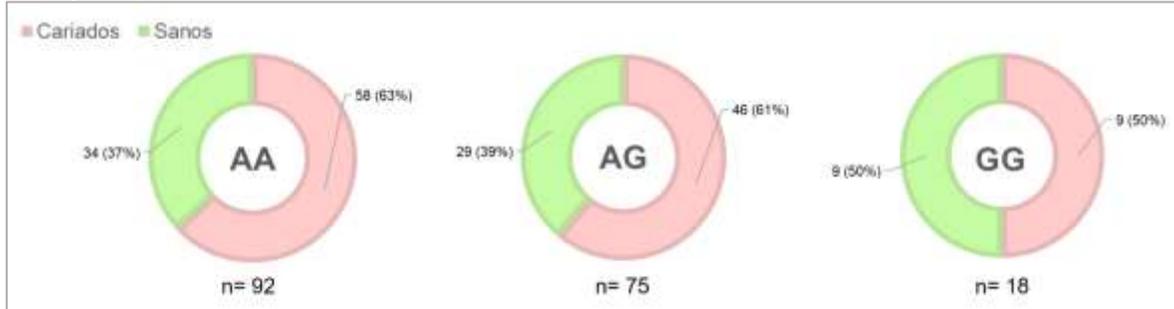
X^2 valor p= 0.58

Tabla 2. Análisis de regresión logística binaria de la asociación del polimorfismo MMP13-77 A/G y la higiene bucal con la caries dental.

Variable	OR (95% CI)	*p*-valor
Alelo		
G	1.0	
A	1.22 (0.77-1.92)	0.37
Genotipo		
GG	1.0	
AG	2.4 (0.79-7.55)	0.12
AA	2.3 (0.76-6.87)	0.14
Uso de seda dental		
Sí	1	
No	1.55 (0.48-4.98)	0.46
Placa Dentobacteriana		
No visible	1	
Visible	3.23 (1.08-9.6)	0.03

Nivel de significancia < 0.05.

4. DISCUSIÓN

Se ha sugerido que los factores ambientales posiblemente no son suficientes para determinar la susceptibilidad a la caries en todos los individuos y que algunas alteraciones genéticas podrían ser potenciales biomarcadores de la predisposición a la enfermedad [23]. Este estudio fue conducido para evaluar la influencia de los factores ambientales y del polimorfismo en el gen MMP13 sobre la susceptibilidad a la caries dental en una población de escolares salvadoreños.

En el presente estudio, no se encontraron diferencias significativas en la experiencia de caries entre niños y niñas. Sin embargo, se encontró un riesgo significativamente menor en los escolares de más edad. Esto podría deberse a que estos sujetos, cuentan predominantemente con dientes permanentes recién erupcionados en cavidad oral y por lo tanto, se espera que se encuentren sanos. Este resultado es concordante con lo reportado en otros estudios que han incluido niños y adolescentes [24,25].

Por otra parte, es conocido que una higiene bucal deficiente y la constante exposición a una dieta cariogénica contribuyen al desarrollo de la caries, debido a las fluctuaciones intermitentes del pH salival que conducen a la desmineralización del diente [26]. De acuerdo a nuestros resultados, la frecuencia del cepillado dental, el uso de seda dental y el consumo semanal de bebidas azucaradas, no están asociados con el riesgo de caries. Sin embargo, fue limitación del estudio que esta información se obtuvo a partir de las declaraciones de los padres o cuidadores. Por esta razón, adicionalmente, se registró la placa dental visible como indicador clínico de la higiene bucal. Al respecto, se encontró que la presencia de placa visible en las superficies dentales incrementa el riesgo de caries 3,23 veces en comparación con los que no presentaron placa visible durante el examen bucal.

El MMP13-77 A/G rs2252070, localizado en la región promotora parece alterar la expresión del gen [25]. Se ha demostrado que este SNP está asociado con algunas enfermedades como la osteoartritis, artritis reumatoide, enfermedades vasculares y diferentes tipos de cáncer [27,28]. A nivel de la cavidad bucal, el poliformismo ha

sido relacionado con la enfermedad periodontal, cáncer bucal, defectos del desarrollo dental y caries [29,30]. Por tanto, conocer la distribución genética de rs2252070 en una población podría contribuir de manera importante a la identificación de sujetos en riesgo y a la prevención de enfermedades. Las frecuencias alélicas y genotípicas para MMP13-77 A/G determinadas en este estudio son similares a las reportadas en otras poblaciones [24,25,31].

En la literatura se muestran resultados contradictorios sobre la asociación entre el polimorfismo MMP13-77 A/G y la susceptibilidad a la caries. Çağırır et al demostraron que el alelo MMP13 A incrementa el riesgo de caries en una población de niños y adolescentes turcos [24]. Por su parte, Tannure et al. informaron que portadores brasileños del alelo G tienen un riesgo significativamente menor de caries [25]. De acuerdo a los hallazgos del presente estudio, el MMP13-77 A/G no está relacionado con la experiencia de caries en la población salvadoreña estudiada. Estos resultados son concordantes con los informados por estudios previos en otras poblaciones [32,33].

Es indispensable tener en cuenta, que los criterios de determinación del diagnóstico de la caries dental, podrían variar entre los estudios que han utilizado las puntuaciones de CPOD/ceod y con metodología similar a la nuestra. La experiencia de caries también varía entre las poblaciones. Esto podría deberse a las políticas sanitarias de cada país y a los factores étnicos, ambientales y conductuales del huésped. En tal sentido, es necesario realizar futuros estudios con muestras representativas de la demografía de la población salvadoreña y que incluyan otros polimorfismos relacionados con la formación del esmalte, respuesta inmunológica y receptores del gusto.

En conclusión, se determinaron las distribuciones alélicas y genotípicas de MMP13-77 A/G rs2252070 y se demostró que este polimorfismo no está relacionado a la susceptibilidad de caries en la población salvadoreña seleccionada. Así mismo, los hallazgos del estudio, destacan la importancia de la higiene bucal y la necesidad de aplicar estrategias de prevención de la enfermedad desde temprana edad.

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6. ANEXOS

ANEXO N° 1: DIAPOSITIVAS FINALES

Objetivo General

Asociar la experiencia de caries dental
a las frecuencias genotípica y alélica
del SNP MMP13-77 A/G (rs2252070)
en una población escolar salvadoreña
de 7 a 12 años.

Objetivos Específicos

Determinar la experiencia de caries dental en los sujetos de estudio.

Determinar las frecuencias genotípica y alélica del SNP MMP13.

Analizar la asociación de la experiencia de caries dental a los factores: sexo, edad, prácticas preventivas y SNP MMP-13.

Metodología

Tipo de Estudio

Observacional Transversal Comparativo

Niños con y sin caries dental

De 7 a 12 años — 185

Sin compromiso sistémico

Tiempo y Lugar

El Salvador, 2023-2024

Cálculo Muestral Probabilístico con Granmo

Variables 🦷

- 👫 Sexo
- Edad
- Placa Dental
- Cepillado Dental
- Seda Dental
- Bebidas Azucaradas
- SNP MMP-13

Aprobación Ética

El protocolo fue sometido a revisión y aprobación del Comité de Ética de la Facultad de Odontología de la Universidad de El Salvador.

Metodología
1 Recolección de Muestras y Datos
2 Extracción de ADN genómico
3 Genotipificación de SNP MMP-13

1 Recolección
Año 2023
ENE FEB MAR ABR MAY JUN JUL AG

Recolección de Datos

Recolección de Datos
Consentimiento Informado
1

Recolección de Datos
Cuestionario
2

Recolección de Datos
Evaluación de Placa Dentobacteriana
Silness y Löe

Recolección de Datos
Detección y Diagnóstico de Caries Dental
ICDAS
CPOD

Recolección de Datos
Recolección de Muestra de Células Bucales
3

3 | Genotipificación de SNP MMP-13

Año 2023   Año 2024

PCR RFLP* | OCT | NOV | DIC | ENE | FEB | MAR | ABR | MAY | JUN | JUL | AGO

*Restriction Fragment Length Polymorphism

PCR RFLP

Primera Etapa: PCR para amplificación de MMP13 A/G (445 pb)

Mezcla de PCR
ADN
Primers
Mix (Taq, dNTps, MgCl2)

PCR
Para generar amplicón de MMP13 A/G (rs2252070)

Gel de Agarosa y Electroforesis
Para verificar amplicón de MMP13 (445 pb)

PCR RFLP

Segunda Etapa: Digestión de amplicón con enzima de restricción

62 °C

estandarización de la técnica PCR RFLP es crucial para la validez de los resultados de la genotipificación.

Mezcla para digestión
Amplicón MMP13 (445 pb) y enzima de restricción Bsrl

Digestión en Incubadora

AA   GG   AG

Gel de Agarosa y Electroforesis

3 | Genotipificación de SNP MMP-13

Año 2024

Pasantía de capacitación | ENE | FEB | MAR | ABR | MAY | JUN

Pasantía de capacitación en PCR-RFLP

División de Ciencias Naturales y Exactas, Universidad de Guanajuato, México.

Pasantía de capacitación en PCR-RFLP

Evaluación del ADN

Geles y Electroforesis de verificación de la integridad del ADN

PCR-RFLP en El Salvador
Año 2024
| ENE | FEB | MAR | ABR | MAY | JUN | JUL | AGO |

Ensayos de estandarización de PCR

Ensayo: Temp 50°C
Ensayo: Temp 65°C
Ensayo: 56, 58, 60 °C
Ensayo: 40 ciclos
Ensayo: 6 µL Mix
Ensayo: 8 µL Mix
Ensayo: gel 4%
Ensayo: primers
Ensayo: Temp 62°C
Ensayo: Temp 55°C

Estandarización de amplificación de MMP13 (445 pb)

Condiciones PCR

Reacción
H2O= 8.5 µL
DNA= 2.0 µL
Primer F= 1 µL
Primer R= 1 µL
Mix= 12.5 µL

← 445 pb

Gel de Agarosa 2%
70 vol por 2 horas

← 445 pb

Gel de Agarosa 2%
Vol de gel: 130 mL,
Vol de muestra: 5 µL,
Voltaje de corrida: 70 vol
Tiempo de corrida: 2 horas

Digestión de MMP13 con BsrI

Reacción
Amplicón= 5 µL
Buffer Tango= 1 µL
Enzima BsrI= 0.5 µL
H2O= 3.5 µL

Digestión en incubadora a 62°C durante la noche.

AA	445 pb
GG	197 pb
	248 pb
AG	197 pb
	248 pb
	445 pb

Gel de Agarosa 2%
Vol de gel: 130 mL
Vol de muestra: 5 µL
Voltaje de corrida: 70 vol
Tiempo de corrida: 2 horas

Análisis de Datos

Prueba X^2 del equilibrio de Hardy-Weinberg
Prueba U de Mann-Whitney, prueba X^2
Análisis de regresión logística binaria

Resultados

Slide 1

Resultados

87 (47%) 98 (53%)

Media edad= 10.43 (n=185)

Slide 2

61% Cariados 39% Sanos

Resultados

CPOD =1.19 ± 1.54
ceod= 2.11 ± 2.56

Slide 3

Variables sociodemográficas y hábitos de higiene bucal		Niños con experiencia de caries (n=113)	Sanos (n=72)	p-valor
Edad (media ± DS)		10.26 ± 1.52	10.71 ± 1.23	**0.03***
Sexo n (%)	Masculino	53 (28.6)	34 (18.4)	0.96
	Femenino	60 (32.4)	38 (20.6)	
Frecuencia diaria de cepillado dental n (%)	3 veces	27 (14.6)	17 (9.2)	0.97
	2 veces	67 (36.2)	42 (22.7)	
	1 vez	19 (10.3)	13 (7)	
Uso de seda dental n (%)	Sí	6 (3.3)	7 (3.8)	0.25
	No	107 (57.8)	65 (35.1)	
Consumo semanal de bebidas azucaradas n (%)	1-3 veces	70 (37.8)	47 (25.4)	0.64
	4 o más veces	43 (23.3)	25 (13.5)	
Placa Dentobacteriana n (%)	No visible	93 (50.3)	67 (36.2)	**0.03****
	Visible	20 (10.8)	5 (2.7)	

*Prueba U de Mann-Whitney, $p < 0.05$
**Prueba X^2 , $p < 0.05$

Slide 4

Distribución Alélica MMP13-77 A/G

30% G
A 70%

Resultados

N= 185 sujetos

Slide 5

Distribución Genotípica y Caries

Cariados Sanos

58 (63%) 46 (61%) 9 (50%)
34 (37%) 29 (39%) 9 (50%)

AA 50% AG 40% GG 10%

Prueba X^2 valor p= 0.58
Hardy–Weinberg equilibrium: $X^2 = 0.22$, $p = 0.63$

Slide 6

Análisis de regresión logística binaria

Variable	OR (95% CI)	p-valor
Alelo		
G	1.0	
A	1.22 (0.77-1.92)	0.37
Genotipo		
GG	1.0	0.14
AG	2.4 (0.79-7.55)	0.12
AA	2.3 (0.76-6.87)	0.14
Uso de seda dental		
Sí	1	
No	1.55 (0.48-4.98)	0.46
Placa Dentobacteriana		
No visible	1	
Visible	3.23 (1.08-9.6)	0.03

$p < 0.05$, estadísticamente significativo

Slide 7

Discusión

Slide 8

Estudios realizados

DISEÑO	Transversal
	Caso-control
FENOTIPO	CPO=0 / CPO ≥ 2
	Libre de caries y alta prevalencia
FUENTE ADN	Sangre
	Kit Saliva
	Citocepillo
	Enjuague
GENOTIPIFICACIÓN	Taqman
	Secuenciación
	LightCycler
	PCR RFLP

SNP MMP13 y experiencia de caries

Comparación de frecuencias genotípicas del polimorfismo MMP13-77 A/G en diferentes estudios.

Comparación... MMP13-7...

Caries Research

MMP13 Polymorphism Decreases Risk for Dental Caries

...0.004). Mutant allele carriers for *MMP13* demonstrated a significantly decreased risk for caries (OR = 0.538, 95% CI 0.313–0.926); this result remained significant after adjustment for candidate genes, type of dentition and dietary factors. Al-

La presencia de placa dental visible incrementa el riesgo de caries 3,23 v...

Conclusión

MMP13-77 A/G rs2252070 no está asociado a la experiencia de caries en la población salvadoreña seleccionada.

Relevancia de los resultados

Proporciona información valiosa de la distribución de esta variante genética en una población específica, que puede ser de gran utilidad para determinar los polimorfismos vinculados y no a la caries.

Producción Académica

AÑOS 2021-2024

12 Cursos y Talleres

12 Cursos y Talleres
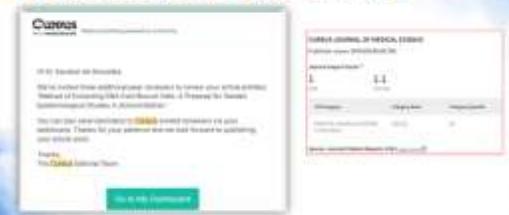
Asistencia a Congresos

Ponencias en Congresos

Memorias de Congresos

Distinciones

Publicaciones Grupo Investigación El Salvador

Publicaciones Grupo Investigación El Salvador

Publicaciones Grupo Investigación El Salvador

Publicaciones

2 Publicaciones

Procesos de Publicaciones

Procesos de Publicaciones

Procesos de Publicaciones

Pasantías

Retribución Social

Idioma Inglés

Gracias

Wendy Yesenia Escobar de González

Artículo 1: Impact of COVID-19 on Dental Practices in El Salvador and Mexico: A Comprehensive Survey Analysis.

Cureus

Impact of COVID-19 on Dental Practices in El Salvador and Mexico: A Comprehensive Survey Analysis

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Abstract

Background and objectives: This study aimed to identify the relationship between prevention measures and protective barriers in dental practice in El Salvador and Mexico during the COVID-19 pandemic in 2020 and 2021.

Materials and methods: A longitudinal study was conducted from June 2020 to December 2021, involving 1,719 dentists divided into four groups based on location and year. A 20-question survey in Spanish was utilized and validated with a Cronbach's alpha value of 0.84.

Results: The use of phone triage (OR = 1.3), thermometers (OR = 1.4), physical distancing (OR = 1.7), and face shields (OR = 2.6) was significantly associated with dental practice in both countries during the pandemic.

Conclusions: During 2020 and 2021, dental care in El Salvador and Mexico was significantly linked to COVID-19 preventive measures. Phone triage, thermometers, distancing, and face shields positively correlated with dental services. National health agencies should promote the use of minimum preventive measures in dental care, preparing for potential reinfections or new pandemics from emerging virus variants.

Categories: Infectious Disease, Dentistry, Occupational Health
Keywords: prevention, covid-19, protective barriers, prevention measures, dental care service

Introduction

In January 2020, the Chinese Illness Prevention and Control Center officially announced a coronavirus as the pathogen causing COVID-19 [1]. Since then, COVID-19 has emerged as a significant public health issue, altering lifestyles worldwide [2]. As of September 2022, 609 million cases had been identified, and 6.5 million deaths were reported globally [3]. Various health professions have been deemed high-risk due to virus transmission. Consequently, modifications in health services and the implementation of preventive measures and protection barriers in clinical practice became imperative [4].

Dental interventions, including direct or indirect contact with mouth tissues, instrument handling, and aerosol generation, pose risks for COVID-19 transmission among dentists and patients [4,5]. As a preventive strategy, the World Health Organization (known as OMS in Spanish), Guidance for Dental Settings, and the Cochrane community initially recommended restricting routine oral health services to emergencies in many world regions [6-8]. Subsequently, governments worldwide established prevention protocols related to patient services as part of their pandemic initiatives [9].

In 2020, standard infection control measures in routine clinical practices seemed inadequate to halt the spread of COVID-19. Health professionals had to adapt their clinical practices to serve patients during the pandemic [10].

Some of these preventive measures included reducing the number of dental service locations, using phone triage, infrared thermometers, handwashing, maintaining physical distancing (at least one meter between patients), employing techniques to prevent aerosol generation, and surface disinfection [11].

Additionally, protective barriers, such as gloves, fluid-resistant face masks, safety goggles or face shields,

disposable surgical caps, gowns, and personal protective equipment, were recommended to prevent contagion [12]. These changes have profoundly affected health professionals and patients worldwide.

The moment is suitable for 1) identifying information related to prevention measures, 2) analyzing and reevaluating preventive measures and protection barriers used in clinical practices, and 3) proposing and establishing prevention-based protocols to enhance dental services. Thus, this study's objective was to identify the association between dental care service and prevention measures and protective barriers used in clinical practice in El Salvador and Mexico during COVID-19 in 2020 and 2021.

Materials And Methods

A longitudinal study was conducted from June 2020 to December 2021 in El Salvador and Mexico. Participants voluntarily decided to partake in the survey. Participant anonymity was ensured to maintain the privacy and confidentiality of all collected information. The study received approval from the Research Ethics Committee of the Autonomous University of San Luis Potosi, San Luis Potosi, Mexico, and the Research Ethics Committee of the University of El Salvador, San Salvador, El Salvador.

Study population

The population comprised dentists working in clinics, hospitals, or health centers in El Salvador and Mexico.

Sample selection

The study instrument (questionnaire) was disseminated through various Facebook groups across all Mexican states (32 states) and all Salvadoran departments (14 departments). At least one Facebook group of dentists from each Mexican state and each Salvadoran department participated in the study. Consecutive non-probabilistic sampling was employed. The states and departments from Mexico and El Salvador were categorized into three regions: Central, North, and South. Ultimately, the questionnaire was accessible via a link to the Google Forms platform.

Sample size

Sample Size Calculation in Mexico

The required minimum sample size was 347, with an estimated total of approximately 70,000 dentists, a 50% probability, a 3% margin of error, and a 99% confidence level.

Sample Size Calculation in El Salvador

The required minimum sample size was 293, with an estimated total of approximately 1,800 dentists, a 50% probability, a 3% margin of error, and a 99% confidence level. The samples were determined using the sample size formula for finite populations.

Study instrument (questionnaire design)

After reviewing national and international publications, 16 questions in Spanish were formulated (Appendices). The survey assessed variables such as sociodemographic characteristics, dental care service, prevention measures, and personal protection barriers. Responses were dichotomous (Yes or No). The questionnaire underwent pre-testing for validity and reliability with 30 dentists, achieving a satisfactory Cronbach's alpha value of 0.84 (p < 0.05).

Two periods of time (longitudinal study)

The questionnaire was distributed during two periods in El Salvador and Mexico: first, between June and July 2020, and second, between October and December 2021.

Statistical analysis

In the univariate analysis, categorical variables were presented as frequencies and percentages, while continuous variables were expressed as means and standard deviations. The bivariate analysis utilized the Chi-square test to determine differences between groups. A binary logistic regression analysis was constructed with dental care service as the dependent variable (1 for presence and 0 for absence). Independent variables included infrared thermometer, phone triage, handwashing, physical distancing (at least one meter between patients), face shield, and disposable gown.

A variance inflation factor (VIF) analysis test was conducted to detect and mitigate multicollinearity among the independent variables. The specification error test verified the assumption that the response variable's logit is a linear combination of the independent variables. After establishing the main effects, interactions were tested, but none were significant. The model's overall fit was assessed using the goodness of fit test. The association between dependent and independent variables is presented as odds ratios (OR) with 95%

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confidence intervals (CI). P-values < 0.05 were deemed statistically significant. Data was analyzed using JMP ver. 15 (SAS Institute, Cary, NC) statistical software [13].

Results

A total of 1,719 dentists participated in the study: 964 from El Salvador and 755 from Mexico. These health professionals were divided into four groups:

1. El Salvador 2020: 528 dentists of both genders (69%, n= 365 women) aged between 25 and 75 years (44 ± 10) responded to the survey in 2020.

2. El Salvador 2021: 436 professionals of both genders (67%, n= 292 women) aged between 25 and 74 years (44 ± 11) responded in 2021.

3. Mexico 2020: 358 dentists of both genders (59%, n= 210 women) aged between 23 and 76 years (37 ± 10) responded in 2020.

4. Mexico 2021: 397 professionals of both genders (67%, n= 268 women) aged between 23 and 69 years (35 ± 9) responded in 2021.

The study encompassed all states and departments from Mexico and El Salvador, which were categorized into three regions: central, north, and south. In the El Salvador 2020 group, 75% (n= 392) of dentists hailed from the central region, 11% (n= 59) from the north, and 14% from the south. In the El Salvador 2021 group, the distribution was 73% (n= 318) from the central region, 8% (n= 34) from the north, and 19% (n=84) from the south.

In Mexico, the 2020 group had 66% (n= 237) of dentists from the central region, 27% (n= 34) from the north, and 7% (n=84) from the south. The 2021 group had 48% (n= 191) from the central region, 36% (n= 143) from the north, and 16% (n= 63) from the south.

Regarding dental care service, Table 1 displays the dental care service during COVID-19 in El Salvador and Mexico for 2020 and 2021. In El Salvador, 30% (2020) and 40% (2021) of dentists halted their clinical practice. In Mexico, the percentages were lower, with 5% (2020) and 3% (2021) of dentists ceasing their clinical practice. Initially and throughout the COVID-19 contingency, dental services in El Salvador shifted, primarily catering to emergency cases (2020: 37%, 2021: 49%, p= 0.0001). In Mexico, 2020 saw a surge in emergency cases (78%, n= 277). However, by 2021, most dental services incorporated preventive measures and protection barriers (86%, n= 339). In both countries, the percentages of dental services provided by health professionals were high at the onset and during the contingency (El Salvador: 65%, Mexico: 96%).

Groups	El Salvador 2020 N (%)	El Salvador 2021 N (%)	Total	P-value	Mexico 2020 N (%)	Mexico 2021 N (%)	Total	P-value
Suspension of dental care	159 (30)	175 (40)	334	0.0001	18 (5)	13 (3)	31	0.0001
Emergency only	195 (37)	212 (49)	407	0.0001	277 (78)	45 (11)	322	0.0001
Dental care with preventive measures and protection barriers	174 (33)	49 (11)	223	0.0001	63 (17)	339 (86)	402	0.0001
Total	528 (100)	436 (100)	964		358 (100)	397 (100)	755	

TABLE 1: Dental care service during COVID-19 in El Salvador and Mexico in 2020 and 2021.

Statistical test: Chi-square

The preventive measures taken in clinical practice for COVID-19 in El Salvador and Mexico during 2020 and 2021 can be observed in Table 2. Measures such as phone triage, use of thermometers, hand washing, physical distancing (maintaining at least one meter between patients), and techniques to prevent aerosol generation were commonly employed. In El Salvador, we observed high utilization rates for thermometers (2020= 93%, 2021= 84%), hand washing (2020= 72%, 2021= 97%), and physical distancing (2020= 69%, 2021= 90%). In Mexico, notable percentages were observed in the use of phone triage (2020= 88%), infrared thermometers (2021= 84%), hand washing (2020= 96%, 2021= 99%), and physical distancing (2021= 96%).

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Groups	El Salvador 2020 (n=369) N (%)	El Salvador 2021 (n=261) N (%)	Total	P-value	Mexico 2020 (n=340) N (%)	Mexico 2021 (n=384) N(%)	Total	P-value
Phone triage								
Yes	169 (46)	98 (38)	267	0.0385	299 (88)	203 (53)	502	0.0001
No	200 (54)	163 (62)	363		41 (12)	181 (47)	222	
Infrared thermometer								
Yes	343 (93)	219 (84)	562	0.0004	170 (50)	322 (84)	492	0.0001
No	26 (7)	42 (16)	68		170 (50)	62 (16)	232	
Handwashing								
Yes	266 (72)	254 (97)	520	0.0001	326 (96)	381 (99)	707	0.0001
No	103 (28)	7 (3)	110		14 (4)	3 (1)	17	
Physical distancing								
Yes	254 (69)	236 (90)	490	0.0001	212 (62)	370 (96)	582	0.0001
No	115 (31)	25 (10)	140		128 (38)	14 (4)	142	
Use of techniques that prevent the generation of aerosols								
Yes	80 (22)	179 (69)	259	0.0001	64 (19)	236 (62)	300	0.0001
No	289 (78)	82 (31)	371		276 (81)	148 (38)	424	

TABLE 2: Prevention measures in clinical practice during COVID-19 in El Salvador and Mexico in 2020 and 2021.

Statistical test: Chi-square. Physical distancing: space of at least one meter between patients.

Table 3 displays the use of personal protective barriers in clinical practice during COVID-19 in both countries for the years 2020 and 2021. In El Salvador, high utilization rates were noted for N95 face masks (2020= 95%, 2021= 97%), gloves (2020= 100%, 2021= 98%), safety goggles (2020= 100%, 2021= 96%), surgical caps (2020= 100%, 2021= 97%), and face shields (2020= 100%, 2021= 97%). In Mexico, the prevalent use of gloves (2020= 98%, 2021= 99%), safety goggles (2020= 92%, 2021= 93%), disposable gowns (2020= 90%, 2021= 98%), face shields (2020= 95%), and personal protective equipment (2021= 99%) was observed.

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Groups	El Salvador 2020 (n=369) N (%)	El Salvador 2021 (n=261) N (%)	Total	P-value	Mexico 2020 (n=340) N (%)	Mexico 2021 (n=384) N (%)	Total	P-value
N95 face mask								
Yes	351 (95)	254 (97)	605	0.1544	236 (70)	289 (75)	525	0.0787
No	18 (5)	7 (3)	25		104 (30)	95 (25)	199	
Other types of face masks								
Yes	255 (69)	261 (100)	516	0.0001	143 (42)	256 (67)	399	0.0001
No	114 (31)	0	114		197 (58)	128 (33)	325	
Gloves								
Yes	369 (100)	256 (98)	625	0.0229	333 (98)	380 (99)	713	0.2629
No	0	5 (2)	5		7 (2)	4 (1)	11	
Googles or glasses								
Yes	369 (100)	250 (96)	619	0.0001	310 (92)	356 (93)	666	0.4491
No	0	11 (4)	11		30 (8)	28 (7)	58	
Disposable gown								
Yes	168 (45)	247 (95)	415	0.0001	307 (90)	373 (98)	680	0.0001
No	201 (55)	14 (5)	215		33 (10)	11 (2)	44	
Disposable surgical cap								
Yes	369 (100)	254 (97)	623	0.0004	281 (83)	342 (89)	623	0.0129
No	0	7 (3)	7		59 (17)	42 (11)	101	
Face shield								
Yes	369 (100)	253 (97)	622	0.0003	324 (95)	341 (89)	665	0.0001
No	0	8 (3)	8		16 (5)	43 (11)	59	
General Personal Protective Equipment								
Yes	86 (23)	230 (88)	316	0.0001	227 (67)	379 (99)	606	0.0055
No	283 (77)	31 (12)	314		113 (33)	5 (1)	118	

TABLE 3: Personal protection barriers in clinical practice during COVID-19 in El Salvador and Mexico in 2020 and 2021.

Statistical test: Chi-square

The association between dental care service, preventive measures, and protective barriers for COVID-19 in El Salvador and Mexico during 2020 and 2021 can be observed in Table 4. The use of phone triage (OR = 1.3, 95% CI = 1.05-1.66, p = 0.0163), thermometers (OR = 1.4, 95% CI = 1.09-1.82, p = 0.0074), physical distancing (OR = 1.7, 95% CI = 1.28-2.25, p = 0.0002), and face shields (OR = 2.6, 95% CI = 2.00-4.00, p = 0.0001) were significantly associated with dental care service in both countries during the COVID-19 pandemic.

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Groups	El Salvador 2020-2021 (n=630) OR	95% CI	P-value	México 2020-2021 (n=724) OR	95% CI	P-value	El Salvador México 2020-2021 (n= 1,354) OR	95% CI	P-value
Phone triage	1.7	1.17-2.50	0.0049	5	3.40-8.20	0.0001	1.3	1.05-1.66	0.0163
Infrared thermometer	----	----	----	3	2.30-5.01	0.0001	1.4	1.09-1.82	0.0074
Physical distancing	1.5	1.01-2.01	0.0437	4	3.00-7.00	0.0001	1.7	1.28-2.25	0.0002
Handwashing	2	1.29-3.00	0.0019	----	----	----	----	----	----
Use of protection barriers									
Disposable gown	2	1.50-3.00	0.0003	3	0.11-0.60	0.0011	----	----	----
Face shield	----	----	----	3	0.13-0.54	0.0001	2.6	2.00-4.00	0.0001

TABLE 4: Binary logistic regressions for association the dental care service with the preventive measures and protection barriers during COVID-19 in El Salvador and Mexico in 2020 and 2021.

Dependent variable: dental care service. Physical distancing: Space of at least one meter between patients. OR: Odds ratios. CI: Confidence intervals.

Discussion

The onset of the COVID-19 pandemic necessitated modifications in clinical care and practice across the healthcare sector. This study aimed to identify the association between dental care services and the preventive measures and protective barriers employed in clinical practice in El Salvador and Mexico during the years 2020 and 2021. Given the findings, we believe it is essential to identify and analyze dental care services, preventive measures, and protective barriers in clinical settings to enhance patient care.

Health care service

During the first months of the pandemic, healthcare workers around the world seemed to have a positive attitude, good knowledge, and good management of preventive measures when facing the COVID-19 pandemic. For example, in the study by Shi et al., the authors found that in a Chinese population made up of psychiatric doctors and nurses, 90% of them had extensive knowledge about COVID-19. In addition, 60% of those surveyed had received training in the management of suspicious patients or patients with COVID-19. Likewise, almost 80% of those surveyed were willing to care for patients with COVID-19 [14].

In the American continent, health professionals also had to make changes to care services during the pandemic [15]. To minimize physical contact between hospital staff and patients, some hospitals reduced their staff presence by up to 80%. Non-urgent patient appointments were also postponed or canceled. While specialized patient care was feasible in the developed nations of the Americas, the situation was more challenging in less developed countries. Initially, healthcare workers maintained an optimistic outlook [16,17].

However, although specialized patient care could be carried out in developed countries of the American continent, the situation was more complicated in less developed countries [18]. In addition, even though at first health workers had an optimistic outlook, as the pandemic period lengthened, the positive attitude was lost and a great deal of stress and concern began to exist among health workers [19].

In the dental community, Posse et al. conducted a survey spanning 59 countries with approximately 400 participating dentists. The study reported that 80% of the dentists limited their clinical activities, with 50% attending only to dental emergencies [16]. Moraes et al. reported a cross-sectional study with a sample of Brazilian dentists. The study found that 36% of dentists suspended dental care, while 58% treated only emergencies [20]. Our survey's initial results in El Salvador and Mexico align with these findings. A significant number of dentists limited their clinical practice during the pandemic's first wave. Those who continued to provide dental care primarily treated emergencies, adhering to recommended preventive measures [16,20,21].

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Moraes et al. conducted another study during the pandemic's second wave in Brazil in May 2021. This survey, which involved around 1,900 dentists, analyzed their clinical practice, knowledge, and attitudes regarding the pandemic. A third of the respondents expressed confidence in vaccine efficacy, with 96% having received at least one vaccine dose. Additionally, 27% reported having contracted COVID-19. The impact of the pandemic on their clinical practice during the second wave was less pronounced than during the first. Most felt well-prepared to treat COVID-19 patients, a sentiment that aligns with our findings in Mexico, where the majority of dentists continued treating patients while adhering to recommended preventive measures [22].

After conducting a bibliographic search, we did not find any articles related to the risk of COVID-19 infection among dentists in Mexico or El Salvador. However, in the United States, the risk of a dentist becoming infected with COVID-19, when using preventive measures, was calculated to be 1 in 13,000 [23]. Brazil was the first country in Latin America to report a positive case of COVID-19. This case was specifically in the state of São Paulo, where an approximately 60-year-old individual, who had traveled from Italy, was diagnosed with the disease [24].

Various authors in Europe and America have identified a significant number of dentists infected with COVID-19 [16]. Moraes et al. reported that, in a sample of 2,127 dentists from 11 Latin American countries, nearly 5% were found to be infected by COVID-19 [9]. In light of these findings, several researchers have published studies related to the use of preventive measures and protective barriers [25].

Preventive measures and protective barriers

Nepal et al. surveyed approximately 350 health professionals, including medical assistants, nurses, and doctors. Generally, the respondents demonstrated an intermediate to high level of knowledge about COVID-19 and exhibited an intermediate to moderate understanding of practices and prevention of COVID-19 infections [26].

In studies focusing on dentists, varied results have been reported concerning their knowledge of COVID-19 and the implementation of preventive measures. Kamate et al. conducted a survey spanning five continents to explore changes in dental practices during the COVID-19 crisis. An overwhelming 99% of the participants indicated that they adopted preventive measures against COVID-19, though the specific measures were not detailed [27]. Gambhir et al. carried out a survey involving approximately 200 dentists. While a majority displayed a comprehensive understanding of COVID-19 and its transmission routes, only 30% reported a thorough knowledge and utilization of personal protective equipment [28].

Several authors have highlighted the widespread use of preventive measures such as phone triage, infrared thermometers, handwashing, physical distancing (maintaining at least one meter between patients), and techniques to minimize aerosol generation [24,26,29]. Gold et al. noted that in US hospitals, every admitted patient underwent evaluation both over the phone and in person to ascertain potential COVID-19 infection. Those suspected were isolated for 14 days, with confirmed cases being closely monitored throughout their isolation period. Additionally, hospitals introduced measures to reduce physical interactions between doctors and patients [17]. Abed et al. executed a national web-based cross-sectional survey from November 2020 to January 2021. Their findings revealed that in Qatar, only 50% of health professionals, a majority of whom were dentists, utilized personal protective equipment. The most commonly adopted infection control measure was handwashing [30].

Balkaran et al. conducted a study across Caribbean countries using a questionnaire distributed via email. Although this study spanned several countries, it only involved 152 dentist participants. From the results, a majority of the dentists identified aerosol production during dental consultations as the primary source of contagion. Nearly 70% of the participants expressed willingness to get vaccinated, and approximately 95% reported using personal protective equipment [31].

Dentists in Mexico and El Salvador have been diligent in adhering to preventive measures and using personal protective equipment, a trend consistent with findings from previous studies [21,32].

Association between dental care service and preventive measures

The COVID-19 pandemic has significantly altered clinical care and practices. In this study, data from 1,719 dentists from El Salvador and Mexico were analyzed. The utilization of phone triage (OR = 1.3, 95% CI = 1.05-1.66, p = 0.0163), infrared thermometers (OR = 1.4, 95% CI = 1.09-1.82, p = 0.0074), physical distancing (OR = 1.7, 95% CI = 1.28-2.25, p = 0.0002), and face shields (OR = 2.6, 95% CI = 2.00-4.00, p = 0.0001) were found to be associated with dental care services during the COVID-19 period.

These findings can be utilized to a) gather information on the subject, b) reevaluate the preventive measures and protective barriers currently in use to determine their relevance in professional practice and c) develop and implement protocols aimed at addressing and mitigating challenges similar to or more complex than those posed by the COVID-19 pandemic. It is plausible that the identified variables associated with dental care services might become standard practices to enhance patient care. The current situation underscores

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the importance of preventive practices and minimally invasive techniques [33,34].

In the literature, there are few longitudinal studies focused on evaluating the use of COVID-19 prevention measures in dentistry and medical practice in general. However, our results align with those of other similar longitudinal studies. For instance, in June 2021, a study analyzed the prevalence and incidence of COVID-19 infection in dentists over a six-month period. The study's findings showed that dentists who maintained prevention measures, such as the use of personal protective equipment, had the lowest percentages of prevalence and incidence of COVID-19 infection over the six months evaluated [35]. Another study published in 2022 assessed the use of biosecurity measures during dental care in preventing COVID-19 infections over a three-month period. The study's results demonstrated that maintaining prevention measures significantly reduced the rates of COVID-19 infection during dental care [36]. Therefore, the results of the two aforementioned studies, along with the findings of the present study, reinforce the theory that maintaining minimum prevention measures, even after the most severe infection waves of COVID-19 could help prevent new pandemics and avoid potential COVID-19 infection outbreaks [37], which can arise from the extreme relaxation of prevention measures [38] or new virus variants that continue to emerge [39].

Limitations of the study

The study, focusing solely on El Salvador and Mexico, may not be generalizable to other countries with distinct healthcare systems or COVID-19 dynamics. Relying on a 16-question survey introduces potential biases from self-reporting and might not encompass the full scope of the topic.

Conclusions

During 2020 and 2021, in El Salvador and Mexico, a significant association was observed between dental care services and various preventive measures and protective barriers against COVID-19. Specifically, the use of phone triage, thermometers, physical distancing, and face shields showed a positive correlation with the provision of dental services in both countries. These findings underscore the importance of national public health agencies promoting the implementation and adherence to minimum safety measures in dental care, even though the most severe waves of COVID-19 have passed. All of this is to be previously prepared to deal with new pandemics or the possible resurgence of reinfection waves that have been observed when relaxing prevention measures due to the continuous presence of new virus variants.

Appendices

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Questionnaire items	
1. Gender	Male/female
2. Age	
3. In which state of the country do you reside?	
4. What decision did you make regarding your daily consultation during the pandemic?	Suspension of dental care
	Emergency only
	Dental care with preventive measures and protection barriers
5. Did you perform telephone triage?	Yes
	No
6. Did you use the infrared thermometer?	Yes
	No
7. Did you wash your hands?	Yes
	No
8. Did you carry out physical distancing?	Yes
	No
9. Did you use techniques to prevent the generation of aerosols?	Yes
	No
10. Do you use N95 face mask?	Yes
	No
11. Do you use another type of facial mask?	Yes
	No
12. Do you use gloves?	Yes
	No
13. Do you use protective glasses or Googles?	Yes
	No
14. Do you use a disposable surgical cap?	Yes
	No
15. Do you use a face shield?	Yes
	No
16. Do you use personal protective equipment?	Yes
	No

TABLE 5: Questionnaire items

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Artículo 2. Depression and opinion of dental students regarding the hybrid learning model during the COVID-19 pandemic.

RESEARCH   **Open Access**

Depression and opinion of dental students regarding the hybrid learning model during the COVID-19 pandemic

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Abstract

Background The global spread of COVID-19 forced schools at all educational levels to close, which was repeated in more than 60 countries. In addition, the COVID-19 pandemic has affected the mental health of dental students world wide. This study hypothesizes that the prevalence of depression in dental students from El Salvador is higher than that reported in studies from Europe, Asia, and North America.

Methods This study was an online cross-sectional survey performed at the Faculty of Dentistry of the University of Salvador. The PHQ-9 questionnaire was applied to know the level of depression of the students, and a questionnaire focused on learning the opinion of the students on the hybrid teaching model adopted. Approximately 450 students participated in both questionnaires.

Results Regarding the levels of depression present in the students, 14% had minimal depression, 29% had medium depression, 23% had moderate depression and, 34% had severe depression. The students had an excellent opinion regarding the hybrid learning model.

Conclusions The prevalence of depression in dental students in El Salvador seems to be higher than that reported in studies in non-Latin American countries. Therefore, universities must generate care plans for mental health to avoid these harmful effects on students during future contingencies.

Keywords COVID-19, Depression, Dental students, Pandemics, Prevalence, Epidemiology

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Introduction

The disease that caused the most recent pandemic that affected the world was initially identified in December 2019 in Wuhan, China. This respiratory viral disease was named coronavirus disease 2019 (COVID-19). Approximately three months later, on March 11, 2020, COVID-19 was declared a global pandemic by the World Health Organization. Four months after the COVID-19 virus was identified, the first patient diagnosed with COVID-19 in El Salvador was confirmed on March 18, 2020 [1]. According to the global trends of the COVID-19 pandemic [2], experts estimated that 20% of the total population of El Salvador could contract the virus and require hospitalization. Likewise, between 4 and 9% of those infected would require care in intensive care units, which could cause the collapse of the country's health services [3]. The COVID-19 pandemic has been active in El Salvador for approximately two and a half years (from January 3, 2020, to August 2, 2022). During this period, about 191,000 positive cases of COVID-19 have been reported, of which 4,200 incidents have caused death. The fight against the pandemic in El Salvador has consisted of administering approximately 11 million doses of vaccines [1].

The rapid spread of the COVID-19 pandemic worldwide meant that vulnerable populations had to be contained at home. Students are among these vulnerable populations, so classes must be suspended at many different educational levels worldwide. This suspension, in turn, interrupted the student's study plans and activities for a long time. Therefore, online teaching had to be used to try to compensate for the deficiencies in education caused by COVID-19 [4].

However, some university courses, such as dentistry, require theoretical learning and constant clinical practice. Therefore, the clinical practice was the most challenging aspect to compensate for due to the high risk of transmission of COVID-19 and because dental schools had to suspend them entirely. At the same time, they developed strategies to allow students to return to clinical practice safely [5]. Dental education is based on three parts. The first part is the theory, which can easily be carried out through online classes. The second is practical training in simulation labs; virtual reality simulations; however not all faculties worldwide (especially in Latin America) have virtual reality simulators for this purpose. Finally, the third component is clinical practice, which can hardly be replaced. Therefore, it is vital to know the students' opinions on the measures taken during the pandemic to implement hybrid learning models, especially in the Latin American context. In the final months of the pandemic, many dental schools opted for a hybrid education model. The hybrid learning model combines theoretical online teaching with clinical practices to carry out education safely. Mainly, in the final months of the pandemic, the administration of vaccines to the general populous kept the pandemic in control [6, 7].

Likewise, the prolonged confinement during the COVID-19 pandemic also caused a deterioration in the population's mental health within the central psychological affections are stress, anxiety, and depression. In addition, it has been previously reported that catastrophic events (such as pandemics) that have economic and social consequences increase the prevalence of mental illnesses in the population [8]. This prevalence compounds students' psychological problems due to the tremendous cognitive demand and economic issues they present during their university career development, even under normal conditions [9]. Many articles have been published on general depression during the COVID-19 pandemic. However, according to the literature, few studies have been carried out in populations of dental students, and even fewer meet quality criteria. Of these, only one has been carried out in a Latin American population such as Brazil. Therefore, we consider that this article contributes to the study of the prevalence of depression in Latin American dental students. The prevalence in this population can be very different from the others due to specific social and economic factors present in Latin America (for example, gender inequalities, lower economic income, less access to technology and less access to psychological care in Latin American countries) that are very different to those present in first world European, Asian or North American countries [10–12].

This study hypothesizes that the prevalence of depression in dental students from El Salvador is higher than that reported in studies from Europe, Asia, and North America. This study aims to know the different degrees of depression among dental students from the University of El Salvador Faculty of Dentistry and their opinion on the effectiveness of the hybrid model of learning implemented during the final months of the COVID-19 pandemic. Therefore, the first objective of this study is to know the different degrees of depression among dental students at the Faculty of Dentistry of the University of Salvador. The study's second objective is to know the opinion on the effectiveness of the hybrid learning model that the University has implemented during the final months of the pandemic.

Materials and methods

Study type

This was an observational, descriptive, and analytical study. The questionnaires used in this study were distributed to dental students at the Faculty of Dentistry of the University of Salvador between October, November, and December 2021 (Tables 1 and 5). The questionnaires were applied individually through the google forms platform.

Table 1 Questionnaire to determine levels of depression of dental students (PHQ-9).

Over the last four weeks, how often have you been bothered by any of the following problems?

	Not at all	Several days	More than half the days	Nearly every day
1. Little interest or pleasure in doing things?	0	1	2	3
2. Feeling down, depressed or hopeless	0	1	2	3
3. Trouble falling asleep, staying asleep, or sleeping too much	0	1	2	3
4. Feeling tired or having little energy	0	1	2	3
5. Poor appetite or overeating	0	1	2	3
6. Feeling bad about yourself - or that you're a failure or have let yourself or your family down	0	1	2	3
7. Trouble concentrating on things, such as reading the newspaper or watching television	0	1	2	3
8. Moving or speaking so slowly that other people could have noticed. Or, the opposite - being so fidgety or restless that you have been moving around a lot more than usual	0	1	2	3
9. Thoughts that you would be better off dead or hurting yourself in some way	0	1	2	3

Table 2 Demographic characteristics from the questionnaire about the hybrid learning model

1. Age (median, range)	21 (17–36)
2. Gender	Frequency (%)
Male	116 (25)
Female	347 (75)
3. Semesters	Frequency (%)
II	105 (22)
IV	138 (30)
VI	82 (18)
VIII	25 (5)
X	31 (6)
XII	37 (9)
XIV	45 (10)

* The results are reported by frequencies and percentages

Inclusion and exclusion criteria

Inclusion criteria were enrolled students, students of both genders, and students of any age. The exclusion criteria were: students dropped out during the period of application of the questionnaires.

Table 3 Association between levels of depression with age group, gender, and semester of dental students

Factors	No depression	With depression	Total	Chi-square	p-Value
Age groups					
<21	121	150	271	1,053	0.3048
>21	95	97	192		
Gender					
Female	151	196	347	5,474	0.0193[a]
Male	65	51	116		
Semesters					
Initial	147	178	325	0,8853	0.3468
Advanced	69	69	138		

[a]p < 0.05 indicates a significant association with depression.

Table 4 Demographic characteristics from the questionnaire about the hybrid learning model

1. Age (median, range)	21 (17–36)
2. Gender	Frequency (%)
Male	105 (23)
Female	347 (77)
3. Semesters	Frequency (%)
II	101 (22.3)
IV	127 (28)
VI	75 (16.6)
VIII	32 (7)
X	39 (8.6)
XII	35 (8)
XIV	43 (9.5)

* The results are reported by frequencies and percentages

Ethical approval

The approval of the ethics committee of the University of El Salvador was obtained.

Questionnaire to determine levels of depression of dental students

The questionnaire used to determine the levels of depression of dental students was the Patient Health Questionnaire-9 (PHQ-9). This questionnaire consisted of two parts: the first included nine questions, and the second included a single question [13]. The PHQ-9 is a questionnaire that evaluates the presence of depression symptoms in the last four weeks. The questionnaire classified the symptoms into 4 degrees of depression, which were:

- • Minimal/no depression (score: 0–4).
- • Mild depression (score: 5–9).
- • Moderate depression (score:10–14).
- • Severe depression (score: 15–27).

In a recent study, the PHQ-9 showed good sensitivity (0.88), specificity (0.85), and 95% confidence interval

Table 5 Questionnaire to evaluate the attitude of students towards the hybrid learning model

Questions	Answers	Frequency	%	95% confidence interval
4. I am satisfied with the effectiveness of learning the online courses:	Strongly agree	29	6.4	0.044–0.091
	In agreement	90	19.9	0.163–0.239
	Neutral	227	50.2	0.455–0.549
	In disagreement	83	18.4	0.149–0.223
	Strongly disagree	23	5.1	0.033–0.076
5. The learning effectiveness of online courses is better than that of face-to-face courses:	Strongly agree	14	3.1	0.017–0.052
	In agreement	22	4.9	0.031–0.073
	Neutral	135	29.9	0.257–0.343
	In disagreement	157	34.7	0.303–0.393
	Strongly disagree	124	27.4	0.234–0.318
6. I think that professional dental lab format courses could change to online courses:	Strongly agree	18	4.0	0.024–0.063
	In agreement	35	7.7	0.055–0.107
	Neutral	97	21.5	0.178–0.255
	In disagreement	156	34.5	0.301–0.391
	Strongly disagree	146	32.3	0.280–0.368
7. Are you worried that covid-19 will create financial pressure for your school studies?	Strongly agree	144	31.9	0.276–0.364
	In agreement	161	35.6	0.312–0.402
	Neutral	114	25.2	0.213–0.295
	In disagreement	28	6.2	0.042–0.089
	Strongly disagree	5	1.1	0.004–0.027
8. Are you worried that the pandemic will affect your learning?	Strongly agree	236	52.2	0.474–0.568
	In agreement	139	30.8	0.265–0.352
	Neutral	66	14.6	0.115–0.182
	In disagreement	8	1.8	0.008–0.035
	Strongly disagree	3	0.7	0.001–0.020
9. My institution quickly adapted to hybrid learning:	Strongly agree	48	10.6	0.080–0.139
	In agreement	147	32.5	0.282–0.370
	Neutral	191	42.3	0.376–0.469
	In disagreement	48	10.6	0.080–0.139
	Strongly disagree	29	6.4	0.044–0.091
10. My institution has organized e-learning appropriately:	Strongly agree	44	9.7	0.072–0.129
	In agreement	150	33.2	0.288–0.377
	Neutral	179	39.6	0.350–0.442
	In disagreement	56	12.4	0.095–0.158
	Strongly disagree	23	5.1	0.033–0.076
11. My institution has provided students with training on teaching tools and software used for distance learning:	Strongly agree	37	8.2	0.059–0.112
	In agreement	131	29.0	0.248–0.334
	Neutral	165	36.5	0.320–0.411
	In disagreement	93	20.6	0.170–0.246
	Strongly disagree	26	5.8	0.038–0.084
12. For the online classes, I mainly used the following equipment:	Laptop/desktop pc	356	78.8	0.746–0.823
	Smartphone	90	19.9	0.163–0.239
	Tablet	5	1.1	0.004–0.027
	Computers in an institution outside of the University (for example, public library, internet cafe)	1	0.2	0.000–0.014
13. For the online classes, I mainly used the following network:	Own network	381	84.3	0.805–0.874
	Mobile data	68	15.0	0.119–0.187
	Public access point	1	0.2	0.000–0.014
	Network in an institution outside of the University (for example, public library, internet cafe)	2	0.4	0.000–0.017

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Table 5 (continued)

Questions	Answers	Frequency	%	95% confidence interval
14. The instructions given by most teachers (exam modes, task solving, etc.) are adapted to distance learning:	Strongly agree	39	8.6	0.062–0.117
	In agreement	150	33.2	0.288–0.377
	Neutral	185	40.9	0.363–0.456
	In disagreement	54	11.9	0.091–0.153
	Strongly disagree	24	5.3	0.035–0.079
15. Most teachers are making an effort to facilitate distance learning:	Strongly agree	88	19.5	0.159–0.234
	In agreement	191	42.3	0.376–0.469
	Neutral	125	27.7	0.236–0.320
	In disagreement	36	8.0	0.057–0.109
	Strongly disagree	12	2.7	0.014–0.047
16. Generally, the teaching materials are adequate for the technical demands of online learning:	Strongly agree	31	6.9	0.047–0.096
	In agreement	164	36.3	0.318–0.409
	Neutral	188	41.6	0.370–0.463
	In disagreement	56	12.4	0.095–0.158
	Strongly disagree	13	2.9	0.016–0.049
17. Teachers have generally organized and adapted to online learning:	Strongly agree	57	12.6	0.097–0.161
	In agreement	170	37.6	0.331–0.422
	Neutral	176	38.9	0.344–0.436
	In disagreement	38	8.4	0.060–0.114
	Strongly disagree	11	2.4	0.012–0.044
18. Which of the following was the most used methodology to teach?	Online classes in zoom	63	13.9	0.109–0.175
	Online classes in teams	24	5.3	0.035–0.079
	Online classes in google classroom	171	37.8	0.333–0.424
	Online classes on the university platform	181	40.0	0.355–0.447
	Whatsapp groups	2	0.4	0.000–0.017
	Daily or weekly tasks	11	2.4	0.012–0.044
19. I am concerned about the lack of practical education:	Strongly agree	280	61.9	0.572–0.664
	In agreement	125	27.7	0.236–0.320
	Neutral	44	9.7	0.072–0.129
	In disagreement	1	0.2	0.000–0.014
	Strongly disagree	2	0.4	0.000–0.017
20. I am afraid that it will not be possible to make up for the lack of practical education during my studies:	Strongly agree	171	37.8	0.333–0.424
	In agreement	149	33.0	0.286–0.375
	Neutral	104	23.0	0.192–0.272
	In disagreement	23	5.1	0.033–0.076
	Strongly disagree	5	1.1	0.004–0.027
21. I feel safe with the measures adopted by my institution to continue with clinical and laboratory practice:	Strongly agree	74	16.4	0.131–0.201
	In agreement	140	31.0	0.267–0.354
	Neutral	169	37.4	0.329–0.420
	In disagreement	43	9.5	0.070–0.126
	Strongly disagree	26	5.8	0.038–0.084
22. I feel confident in serving patients in clinical practices:	Strongly agree	47	10.4	0.078–0.136
	In agreement	95	21.0	0.174–0.251
	Neutral	167	36.9	0.325–0.416
	In disagreement	90	19.9	0.163–0.239
	Strongly disagree	53	11.7	0.089–0.151

Table 5 (continued)

Questions	Answers	Frequency	%	95% confidence interval
23. The pandemic has affected my manual dexterity, and this is reflected in the quality of the treatments I perform:	Strongly agree	74	16.4	0.131–0.201
	In agreement	118	26.1	0.221–0.304
	Neutral	196	43.4	0.387–0.480
	In disagreement	49	10.8	0.082–0.141
	Strongly disagree	15	3.3	0.019–0.055
24. I feel confident caring for patients who have recovered from COVID-19:	Strongly agree	71	15.7	0.125–0.194
	In agreement	123	27.2	0.232–0.316
	Neutral	175	38.7	0.342–0.433
	In disagreement	55	12.2	0.093–0.156
	Strongly disagree	28	6.2	0.042–0.089

* The results are reported by frequencies and percentages

(0.82 to 0.88). This study employed the Spanish version of the PHQ-9 questionnaire. The Spanish version previously reported a specificity of 88%, a sensitivity of 87%, and an accuracy of 88% [14]. The cut-off point used to determine clinically essential levels of depression (moderate to severe depression) was a value equal to or greater than 10 points [15, 16]. In addition, the questionnaire included three questions about the primary demographic data of the participants. Those three questions were about age, gender, and the year of the degree that the participant is studying [17] (Table 1).

Questionnaire to evaluate the opinion of students towards the hybrid learning model

The questionnaire to evaluate the students' opinions towards hybrid learning consisted of 24 questions. The questionnaire was developed based on questions asked in previous studies that have already been published and validated [18–20]. The wording of the questions reported in Table 5 was an English translation from the Spanish version. The first three questions were about the primary demographic data of the participants (Table 3). Questions 4–8 were about the effectiveness of online classes and factors that can affect student performance. The following three questions were about the mechanisms applied by the University to carry out online learning. Questions 12 and 13 were about the students' tools to access online classes. Questions 14–17 were about the performance of professors during online courses. Questions 18 through 24 were about students' clinical practice during the pandemic (Table 4).

Statistical Analyses

The Netquest (GfK group, Núremberg, Germany) online application was used to obtain the study's sample size. A population of 463 students, a heterogeneity of 50%, and a confidence level of 95% were used to calculate the minimum sample size required. The minimum sample size was 211 students. The data analysis was carried out with the software GraphPad Prism version 8.3.1. (Graph Pad Software Inc, California, USA). To obtain the level of depression of each student surveyed, we added the score of each question to get the total points. Finally, the levels of depression were divided into two categories, no depression (below 10) and depression (10 and above), by taking a recommended cut-off score of 10 [21] according to the cut-off point with a score of 10, determined in a previous study. Likewise, the different semesters reported by the students were grouped into two categories, beginning semesters (from semesters 2 to 8) and advanced semesters (from semesters 10 to 14). In both questionnaires, ages were reported as medians and ranges, and gender and semester studied were reported as frequencies and percentages. The analysis of factors associated with depression was performed using the Chi-square test. Cronbach's alpha was calculated for the 21 questions that comprise the questionnaire to assess the students' opinion on the hybrid learning model and the nine questions of the PHQ-9 questionnaire. The study used Cronbach's alpha calculation in RStudio version 2021.09.1+372 "Ghost Orchid" Release (RStudio Team (2021). RStudio: Integrated Development Environment for R. RStudio, PBC, Boston, MA URL http://www.rstudio.com/.) and used the "alpha ()" function from the "psych" package.

Results

Sample Characteristics

The total number of students who answered the mental health survey was 463. 75% of respondents were women, and 25% were men. The median age of the participants was 21 years, with a range of 17 to 36 years of age (Table 2). The total number of dentistry students who answered the questionnaire on the effectiveness of the hybrid learning model was 452. 23% were men, and 77% were women. The median age of the participants was 21 years, with a range of 17 to 36 years of age (Table 4).

Depression levels of dentistry students in El Salvador

Cronbach's alpha value for the PHQ-9 questionnaire was 0.86, with a 95% confidence interval of 0.76 to 0.92. According to the methodology of the PHQ-9 questionnaire, surveyed students' levels of depression were classified into four groups, shown in Fig. 1. The entire study population answered the questionnaire (463 students). 43% of the students reported severe depression, 23% of the students reported moderate depression, and 29% of the students had medium depression. Finally, only 14% of the students did not present depression, or it was minimal (Fig. 1). Regarding the association of the variables of age group (<21,>21), gender, and semester studied (initial or advanced) with the different levels of depression, only gender showed a significant association.

Hybrid Learning Model Assessment

Regarding the questionnaire on the attitude and effectiveness of the hybrid model during the pandemic, Cronbach's alpha value was 0.74 (acceptable) with a 95% confidence interval of 0.64–0.82.

Effectiveness of online classes and factors that can affect student performance (Questions 4–8)

Most students were neutral about the effectiveness of online learning, followed by disagreement with online learning (about 60%). Likewise, most students disagreed
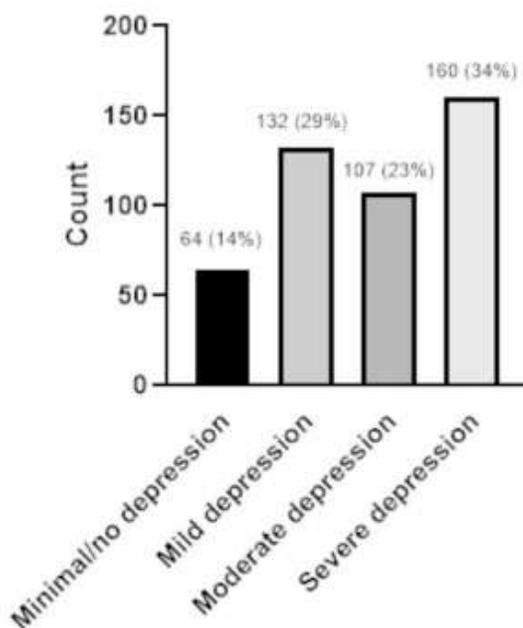

Fig. 1 Results of the frequency and percentage of the different degrees of depression

that the clinical practice laboratories could be taken online (about 67%), and most agreed that the epidemic would affect their learning and cause economic problems (about 66%).

Mechanisms applied by the University to carry out online learning (Questions 9–11)

42% of students considered that the University quickly adapted to the hybrid model, and the other 42% had a neutral opinion (question 9). Likewise, approximately 43% of students considered that the University organized online learning adequately, while the other 40% had a neutral opinion (question 10). Finally, 37% of the students considered that the institution provided adequate tools and training for online learning, while 36.5% had a neutral opinion (question 11).

Students' devices to access online classes (Questions 12 and 13)

Around 80% of the students had their own laptop/desktop pc and internet network.

Professors' performance during online classes (Questions 14–17)

Approximately 40% of the students agreed that the instructions given by the professors were well adapted to distance learning, while the other 60% had a neutral opinion (question 14). 60% of the students considered that the professors made an effort to facilitate distance learning for their students (question 15). Forty-three-point-2% of the students felt that the teaching materials during online learning were adequate, and about 40% had a neutral opinion (question 16). Approximately 40% of the students consider that the teachers have adapted to distance learning, while the other 60% had a neutral opinion (question 17).

Platforms used for online learning (question 18)

The three leading platforms used for online learning were the university platform, google classroom, and zoom.

Students' clinical practice during the pandemic (Questions 19–24)

90% of students were concerned about the lack of clinical practice (question 19). 70% of the students considered that they could not recover the clinical and laboratory course during the rest of their studies (question 20). Around 40% of the students feel safe with the measures taken by the University to continue with clinical practices and laboratories, while the other 60% had a neutral opinion (question 21). Only 30% of students felt safe when treating patients, 37% had an impartial idea, and the remaining 23% did not feel safe (question 22). Approximately 53% of the students did not consider that they had

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lost manual dexterity during the pandemic (question 23). Finally, about 42% of the students felt safe when treating patients who recovered from COVID-19, while approximately 40% had a neutral opinion (question 24).

Discussion

The study's objectives were to know the degrees of depression of dental students during the contingency due to the COVID-19 pandemic and dental students' opinions of hybrid learning implemented by the University of El Salvador Faculty of Dentistry during the COVID-19 pandemic. As far as we know, no studies have been carried out in Latin American countries where the presence of depression in dental students was investigated and where the opinion of students regarding the hybrid learning model was analyzed.

The PHQ-9 was the questionnaire used in this study to detect levels of depression in dental students [22]. This questionnaire has been widely used in previous similar studies [22, 23]. Other widely used questionnaires for the same purpose are the DASS-21 and HADS questionnaire [10, 24]. The total number of students who answered the PHQ-9 questionnaire was 463. Our study has the second largest sample size, only after the survey by Siddiqui & Qian (2021), in which the sample size was 655 students. Likewise, this study has the first place in sample size (463 students) in a Latin American country [25]. The second place is occupied by the study by Medeiros et al. in Brazil, with a sample size of 113 students [10].

The median age of the students who answered the two questionnaires was 21. This data coincides with similar studies in which a mean age of 21 was reported [10]. However, there are studies where the average age reaches 25 [24]. In this study, the percentage of women and men was 75% and 25%, respectively. These percentages are similar to those reported by previous studies. For example, in the survey by Medeiros et al., the authors noted that of the sample studied, 77% were women and, 23% were men [10]. In the German study by Mekhemar et al., the authors reported a percentage of women of 74% and men of 26% [26]. Two studies conducted in Malaysia reported 79% women and 21% men [25, 27]. Shailaja et al. reported 82% of women and 18% of men [28]. On the other hand, Hakami et al. reported more balanced percentages of men and women. The authors reported 55% women and 45% men [29]. The differences in the average age and the ratios of men and women between this study and previous studies are mainly due to the different populations studied. The differences in the number of respondents between the two questionnaires are because the questionnaires were applied independently.

Before the COVID-19 pandemic, depression in dental and medical students was approximately 28% in the US [30, 31]. Previous studies on the prevalence of depression during the general population pandemic report range from 12 to 31% [32, 33]. Deep et al. surveyed the pandemic in which they reported a 9% prevalence of depression in 199 dental students; in this study, the authors used the PHQ-9 questionnaire [34]. Knipe et al. also used the PHQ-9 questionnaire during the pandemic to report the prevalence of depression in dental students. The authors found a prevalence of depression of 35.4% in 344 dental students [35].

This study's prevalence of moderate and severe depression (>10) was 57%. The increased prevalence of depression may be due to the COVID-19 pandemic, which exerts more psychological stress on dental students than they experience under normal conditions. This percentage coincides with similar studies also carried out during the covid-19 pandemic. For example, Medeiros et al. reported with the PHQ-9 a prevalence of depression of 39.4% in 113 dental students in Brazil during the COVID-19 pandemic [10]. Chi et al. also registered with the PHQ-9 a prevalence of depression of 14.4% in 14 US dental students. However, the author's sample size was meager, invalidating the results [23]. Kwaik et al. reported a 70% prevalence of depression in 305 Palestinian dental students. However, the questionnaire used for screening for depression was not the PHQ-9; the authors used the DASS-21 questionnaire, which could explain the high percentage of depression reported [36]. Hakami et al. used the DASS-21 questionnaire to register a prevalence of depression of 60.7% in 422 Saudi Arabian students [29]. Gas et al. used the DASS-21 questionnaire to report a prevalence of depression of 27.2% in 190 dental students from Turkey [37]. It is crucial to consider that the studies mentioned above were carried out during the initial and intermediate stages of the development of the pandemic. In contrast, our research was carried out in the final step. This difference in methodology could explain the considerable variation in the reported percentages of depression questionnaires used to detect depression and the different sample sizes. Finally, our study found a positive association between the degree of depression and female gender, coinciding with the report by Medeiros et al. [10]. However, other studies do not find an association between gender and levels of depression [25]. In general, this study's prevalence of depression in dental students (57%) is higher than that reported in previous studies in Europe, Asia, and North America. For example, in a study that analyzed the mental health of medical science students (including dental students) in 9 countries, an overall prevalence of depression of 40% was found. This study included the countries of Mexico, Colombia, Venezuela, Chile, Brazil, Spain, Germany, Italy, and Japan [38].

A study in the USA reported a prevalence of depression of 14.4% [23]. Two studies conducted in India registered

a prevalence of depression of 53.5% and 20% [22, 28]. Alfadley et al. reported a prevalence of depression of 10.9% [24]. Likewise, two studies in Malaysia reported depression in dental students at 24% and 33.6% [25, 27]. In addition, some studies report that COVID-19 infection in relatives of dental students multiplies by three the probability that they will develop symptoms of depression [39]. The above analyses were conducted during the COVID-19 pandemic and in dental students.

Regarding dental students' attitudes towards the hybrid learning, questions 4 through 8 assess the effectiveness of online classes. Most dental students were neutral (50%) or disagreed (55%) on the efficacy of online learning, which coincides with similar studies reporting that 45% of dental students surveyed indicate that online learning needs to improve to be more effective [19]. In questions 9, 10, and 11 were about the mechanisms applied by the University to carry out online learning, 40% of the students had a neutral opinion, and another 40% agreed that the faculty had adequately adapted to the hybrid model and provided the appropriate tools for online learning. In a study in Jordan, students reported feeling comfortable (54%) with how the faculty implemented online teaching [20]. So, the hybrid model applied in the faculty of El Salvador has a degree of acceptance similar to those used in other parts of the world. Likewise, in this study (questions 12 and 13), 80% of the students had the necessary tools to take classes online. Access to online courses is similar to other studies; for example, in a survey conducted in India, 86.1% of students reported accessing online classes regularly [40]. In questions 14–17 (professors' performance during online courses), 40 and 60% of the students consider that the teachers adapted excellently to online teaching. A similar study affirms this data in Italy, where dental students indicated that 70% of teachers had successfully adapted to online instruction [41]. In this study, the most used platforms to take classes online were the university platform, google classroom, and zoom. These data are very similar to a study in Brazil, where the leading platforms were virtual meetings (Zoom/Skype), the educational platform Moodle and the University system [42]. In questions 19–24 (students' clinical practice during the pandemic), 90% of dental students are concerned about the lack of clinical practice. Several similar studies during the COVID-19 pandemic are consistent with these findings. For example, Etajuri et al. report that more than 50% of dental students do not feel satisfied with the clinical practice received during the pandemic [43]. Hattar et al. said 87% of dental students indicated their clinical practices were affected during the pandemic [20]. Finally, in this study, less than half of the students reported feeling safe when treating patients or with the protection measures adopted by the faculty. This trend has been reported in previous studies [44]. The

general result of the questionnaire on the hybrid learning model indicates that the students were not affected by this learning model, which seems to contradict the depression levels obtained in this study and the results of similar studies. For example, a study conducted at a Lebanese University reported that online learning is associated with increased levels of depression in students [45]. A survey of students from public and private universities in Malaysia reported similar results [46]. The different results between the studies mentioned above and ours could be due to other diagnostic methods for depression and the diverse populations of students and university courses.

Likewise, each region's economic, social, and personality factors can affect the prevalence of depression in students [47]. Latin American countries face aspects of their socioeconomic conditions that can affect mental health— for example, the lack of food in various areas of difficult access [48]. Alfayumi-Zeadna et al. reported that some economic and social factors that increased depression in Israeli students during the pandemic were: low income, job loss, region of residence, marital status, whether they own their home or not, and income level [49]. Yin et al. reported that medical students with low social support were more likely to have high levels of depression [50]. Browning et al. conducted a study in seven states in the United States where they analyzed the social and economic factors that affected students' mental health during the COVID-19 pandemic. The main factors that influenced the students' mental health were: not being in good health, spending little time outdoors, having low income, spending much time in front of the computer, and being a woman. The latter coincides with previous studies that have reported a higher prevalence of depression in women due to different factors such as hormones, interpersonal violence after childhood, body shame and dissatisfaction [51].

Gębska et al. analyzed the relationship between the appearance of physical symptoms (Stomatognathic System Disorders) and the stress generated during the COVID-19 pandemic in physiotherapy students. The authors found a connection between physical symptoms and students with type D personality ('distressed personality') [52]. Type D personality is a type of personality with the characteristic of being more susceptible and generating higher stress levels in complicated situations such as the COVID-19 pandemic. Due to the above, people with this personality type are also more vulnerable to developing moderate or severe levels of depression [53, 54]. With the presence of psychological disorders such as depression, not only did the frequency of temporomandibular disorders increase in students but also increased bruxism associated with depression in dental students during the pandemic [55]. Shailaja et al. reported that

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cyberchondria (when the excessive search for information about a disease on the internet increases the concern about the said disease) is also associated with high stress, anxiety, and depression levels in dental students during the COVID-19 pandemic [28].

Other studies have reported the co-occurrence of psychological disorders and alcohol abuse [56]. For example, the study by Fernandez et al. reported a relationship between alcohol abuse and moderate or severe anxiety levels in dental students in various regions of Brazil during the COVID-19 pandemic [57]. In addition, alcohol abuse by college students during the COVID-19 pandemic was associated with increased suicidal behavior [58–60]. The study by Chang et al. reported that students from rural areas and non-medical majors had fewer psychological symptoms (most had anxiety) compared with students from the suburbs and in medical majors (most had depression) [61]. As reported by Sanabria-Mazo et al., perhaps one of the main factors influencing the development of depression in Latin American students is social inequities (such as income level, employment status, education level, ethnic group, area of residence, and religion) [62]. Likewise, one way to reduce the psychological impact of COVID-19 on Latin American students is through self-employment and entrepreneurship, which helped reduce economic and social inequalities during the pandemic [63].

One of this study's strengths is that the sample size was more extensive than most studies in similar populations. In addition, it was possible to analyze practically the entire population of interest in this study. Regarding the limitations, the questionnaires were applied individually, so we could not determine associations between the variables. The questionnaires were only used in one University, so it is difficult to extrapolate the results to the population of dental students throughout the country.

Conclusions

According to the results of this study, 57% of the students presented moderate or severe levels of depression, which makes them candidates for receiving psychological attention. Therefore, this article contributes to a better understanding of this problem in this type of population [12]. Regardless of the levels of depression, the opinion of the students towards the hybrid learning model turns out to be quite good.

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Publisher's Note

Artículo 3: Method of Extracting DNA from Buccal Cells: A Proposal for Genetic Epidemiological Studies in Schoolchildren

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Artículo 5: Effect of the Combined Application of Silver Nanoparticles and Chitosan Gel on Dental Enamel Remineralization: An In Vitro Study

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Journal: Biomedical Engineering Advances
Title: Effect of the Combined Application of Silver Nanoparticles and Chitosan Gel on Dental Enamel Remineralization: An In Vitro Study
Corresponding Author: Dr. Nereyda Niño-Martínez
Co-Authors: Katleen A. Aguirre de Rodríguez; Wendy Y. Escobar de González; Vianney Castañeda Monroy; Sean Murphy; Gabriel-Alejandro Martínez-Castañón; Horacio Bach
Manuscript Number: **BEA-D-24-00113**

ANEXO N° 3: APROBACIONES DE COMITÉ DE ÉTICA

CIFOUES
Centro de Investigaciones
Facultad de Odontología
Universidad de El Salvador

Comité de Ética de Investigación
Facultad de Odontología
Universidad de El Salvador

Comité de Ética de investigación Facultad de Odontología
Oficio N°: CEI-FOUES /2022/ 001
Fecha: 8 de febrero del 2022

Doctora Wendy Yesenia Escobar de González.
Investigadora Principal
Presente

De nuestra consideración:
Adjunto a Usted, el punto cuatro de la sesión de evaluación N° 01-2022 realizada el 2 de febrero del año dos mil veintidós; que certifica que el Comité de ética de la Facultad de Odontología, entrega **dictamen favorable** *al protocolo de investigación* **"Práctica Clínica Odontológica En El Salvador Durante La Contingencia Covid-19"**

Solicitamos a Usted, comunicar a este Comité el inicio de la ejecución del estudio, así como informar en los plazos establecidos y de forma oportuna según los beneficios del proyecto, cualquier cambio o modificación importante que se realice durante la ejecución de la investigación en la que se vea afectada la participación de los sujetos o población de estudio y que además altere la orientación proyectada con la ejecución de la investigación.

Además, se informa que el tiempo de vigencia de la aprobación del proyecto es de un año, prorrogable de acuerdo a comunicación y solicitud oficial.

CIFOUES
Centro de Investigaciones
Facultad de Odontología
Universidad de El Salvador

Comité de Ética de Investigación
Facultad de Odontología
Universidad de El Salvador

Comité de Ética de Investigación Facultad de Odontología
Oficio N°: CEI-FOUES /2022/ 012
Fecha: 14 de septiembre del 2022

Dra. Wendy Yesenia Escobar de González
Investigadora Principal
Presente

De nuestra consideración:

Adjunto a Usted, el punto cuatro de la sesión de evaluación N° 10-2022 realizada el 14 de septiembre del año dos mil veintidós; que certifica que el Comité de ética de la Facultad de Odontología, entrega **dictamen favorable** *al protocolo de investigación denominado* **"Polimorfismo de un solo nucleótido en Metaloproteinasa 13, como biomarcador genético de susceptibilidad de caries dental en una población escolar salvadoreña".**

Solicitamos a Usted, comunicar a este Comité el inicio de la ejecución del estudio, así como informar en los plazos establecidos y de forma oportuna según los beneficios del proyecto, cualquier cambio o modificación importante que se realice durante la ejecución de la investigación en la que se vea afectada la participación de los sujetos o población de estudio y que además altere la orientación proyectada con la ejecución de la investigación, así mismo cuando haya finalizado su estudio envíe un resumen de sus resultados.

Además, se informa que el tiempo de vigencia de la aprobación del proyecto es de un año, prorrogable de acuerdo a comunicación y solicitud oficial.

ANEXO N° 4: ACTA DE REGISTRO DE TESIS

UNIVERSIDAD AUTÓNOMA DE SAN LUIS POTOSÍ
FACULTAD DE ESTOMATOLOGÍA
DOCTORADO EN CIENCIAS ODONTOLÓGICAS

FACULTAD DE
ESTOMATOLOGÍA
UASLP

ACTA DE DEL REGISTRO DE TRABAJO TERMINAL

En la ciudad de San Luis Potosí. S. L. P., el día primero del mes de diciembre del año dos mil veintidós, en acuerdo previo con la estudiante, con la Directora del Trabajo Terminal y con el Comité Académico del programa se registró en las oficinas del programa de Doctorado en Ciencias Odontológicas el nombre de la estudiante: Wendy Yesenia Escobar de González, el nombre de la Directora del Trabajo Terminal. Nuria Patiño Marin y el Título del Trabajo Terminal: "SNP MMP13, COMO BIOMARCADOR GENÉTICO DE CARIES DENTAL EN POBLACIÓN INFANTIL SALVADOREÑA" en cumplimiento del artículo 73, 74 y 75 del Reglamento General de Estudios de Posgrado de la Universidad Autónoma de San Luis Potosí.

Para constancia se levanta la presente acta que firman el Coordinador y la Directora del trabajo Terminal del programa de Doctorado en Ciencias Odontológicas.

AGRADECIMIENTOS PERSONALES

A Dios, quien ha puesto su mano de principio a fin.

A mi mamá, Sonia Luz Amaya, por sus esfuerzos y su amor.

A mi esposo, Romeo Edgardo González, mi fortaleza.

A mi familia, siempre presentes.

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A mi directora de tesis, la Dra. Nuria Patiño, por la gran oportunidad de trabajar con ella, por sus enseñanzas y motivación para superarme a mí misma en cada etapa.

A mi codirectora, la Dra. Yolanda Terán Figueroa, quien me brindó su apoyo desde el primer momento, compartió sus valiosos conocimientos y siempre me animó.

A mis asesores, la Dra. Nereyda Niño Martínez y el Dr. Carlo Eduardo Medina Solís, por su apoyo, aportaciones y enseñanzas en estos tres años del Doctorado.

A la Mtra. Vianney Castañeda Monroy, el Dr. Jorge Alegría Torres y el Mtro. Aurelio Álvarez Vargas, por permitirme trabajar en sus laboratorios y enseñarme con paciencia y dedicación.