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CORRELATION BETWEEN ORAL HEALTH MORBIDITY AND GOOGLE SEARCH TRENDS IN PERU, 2021–2022

CORRELACIÓN ENTRE LA MORBILIDAD EN SALUD BUCAL Y LAS TENDENCIAS DE BÚSQUEDA EN GOOGLE EN PERÚ, 2021–2022

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ORIGINAL ARTICLE

ABSTRACT

Introduction: Diseases of the oral cavity are increasingly affecting the global population, particularly in developing countries such as Peru. **Objective:** To determine the correlation between oral health morbidity and Google search activity in Peru during 2021–2022. **Methods:** Ecological study. Data on oral health morbidity were obtained from the official website of the National Unified Repository of Health Information (REUNIS, by its Spanish acronym), which compiles records of patients treated at healthcare facilities under the Ministry of Health. Subsequently, Google Trends was used to assess search volumes related to major oral diseases queried through Google in Peru. The Spearman correlation coefficient was applied to evaluate the relationship between quantitative variables, with statistical significance set at $p < 0.05$. **Results:** A very low positive correlation without statistical significance was found between the relative search volume (RSV) for dental wear, tooth loss, and dental malocclusion and their respective number of cases (Spearman's rho = 0.176, p = 0.412; rho = 0.241, p = 0.257; rho = 0.142, p = 0.507, respectively). In contrast, the RSV for dental caries showed a strong positive correlation with statistical significance (rho = 0.751, p = 0.001). **Conclusion:** This study found that dental caries was the only term whose relative search volume had a strong and statistically significant correlation with the number of related clinical consultations.

Keywords: Oral health; Dental caries; Morbidity; Observational study; Peru. (Source: MESH-NLM)

RESUMEN

Introducción: Las enfermedades de la cavidad bucal afectan cada vez más a la población mundial, sobre todo a los países en vías de desarrollo como el Perú. **Objetivo:** Determinar la correlación entre la morbilidad y la búsqueda sobre salud bucal en Perú, 2021-2022. **Métodos:** Estudio ecológico. Se ingresó a la página web del Repositorio Único Nacional de Información en Salud, con el propósito de acceder a la base de datos de morbilidad en salud bucal en pacientes que acudieron a algún establecimiento de salud perteneciente al Ministerio de Salud. Posteriormente, se accedió a la plataforma de Google Trends para determinar la búsqueda de las principales enfermedades bucodentales realizadas a través de Google en Perú. Para determinar la correlación entre variables cuantitativas, se utilizó el coeficiente de correlación de Spearman con un nivel de significancia $p<0,05$. **Resultados:** Se encontró una correlación positiva muy baja y sin diferencias estadísticamente significativas entre el volumen relativo de búsqueda (VRB) sobre desgaste dental, pérdida dental y maloclusión dental con sus correspondientes números de casos (Rho de Spearman= 0,176, p= 0,412; Rho de Spearman= 0,241, p=0,257; Rho de Spearman= 0,142, p=0,507); respectivamente. En contraparte, el VRB sobre caries dental evidencia una correlación positiva fuerte y con diferencias estadísticamente significativas con su número de casos (Rho de Spearman= 0,751, p= 0,001). **Conclusión:** Nuestro estudio encontró que el VRB de caries dental fue el único término que presentó una correlación estadística fuerte y estuvo asociado con el número de atenciones por caries dental.

Palabras claves: Salud bucal; Caries dental; Morbilidad; Estudio observacional; Perú. (Fuente: DeCS- BIREME)

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INTRODUCTION

The World Health Organization (WHO) defines oral health as a state in which the mouth and the oro-facial structures allow eating, breathing, and speaking, considering their psychosocial impact and contribution to overall health [1]. In 2022, WHO reported that oral diseases affect 3.5 billion people, with higher prevalence in developing countries [2]. In Peru, the 2001-2002 epidemiological study by the Ministry of Health (MINSA, by its Spanish acronym) reported a Decayed, Missing, and Filled Teeth index (DMFT-12) of 3.67 at twelve years of age, classified in the growth phase according to the Pan American Health Organization/World Health Organization (PAHO/WHO) [3]. The most frequent oral pathologies include dental caries, periodontal diseases, tooth loss, malocclusions, and dental trauma. These conditions affect quality of life and represent a public health problem[4]. Since 2021, the National Unified Repository of Health Information (REUNIS, by its Spanish acronym) of MINSA has been collecting data on oral health morbidity in Peru [5].

The use of the internet has influenced various aspects of health, including patient decision-making [6]. Google Trends (GT) is a tool that measures search interest on a scale of 0 to 100, based on the relative frequency of queries [7]. GT has proven useful in the field of infodemiology, allowing analysis of disease outbreaks and health-related behaviors [8,9].

Previous studies have shown that GT is effective in assessing the demand for dental treatments and optimizing resource allocation [10]. It has also been identified that terms such as "gingivitis," "cleft palate," and "caries" are among the most searched worldwide in oral health topics [11]. Additionally, a significant association has been reported between media coverage of diseases such as oropharyngeal cancer and increased internet searches, highlighting the impact of digital information on public interest [12]. In Peru, no studies have analyzed user interest in oral health topics or their relation to the demand for healthcare. Therefore, this study aims to determine the correlation between oral health morbidity and internet searches in Peru during the period 2021-2022.

METHODS

Study Design and Area

An ecological multiple-group study was conducted, focusing on the regions of Peru during the period 2021-2022. National databases were used to integrate information on oral health morbidity recorded in MINSA facilities and the relative search volume (RSV) of oral health-related terms in GT.

Population and Sample

The study population consisted of all Peruvian users who accessed Google's search engine, as well as patients who visited MINSA healthcare facilities and were diagnosed with any oral health morbidity during 2021 and 2022. The sample included data on the relative search volume (RSV) in Google Trends for oral health in Peru, as well as records of patients diagnosed with oral diseases in MINSA during the same period. Records that did not contain all the study variables were excluded. The analysis unit corresponded to each month of the 2021-2022 period. For each unit, two main variables were recorded: the number of oral disease cases diagnosed in MINSA facilities and the RSV in GT for oral health-related terms in Peru.

Variables and Instruments

The independent variable was oral health morbidity, defined as the occurrence of diseases, injuries, and disabilities affecting the mouth and its components, diagnosed by dental surgeons in MINSA healthcare facilities. This variable was discrete quantitative, measured by the monthly number of diagnosed patients; these data were obtained from the REUNIS portal[5]. The dependent variable was the relative search volume (RSV) for oral health on the internet in Peru. This index, provided by GT, represents the relative number of searches for a specific term within a given category, location, and time period. The RSV is expressed on a scale from 0 to 100, where higher values reflect

greater user interest or preference for topics related to oral health in Peru. This variable was continuous quantitative, limited to the mentioned range [7]. The collected data were organized in a collection sheet specifically designed to systematize the information obtained from secondary databases.

Procedures

The REUNIS portal (https://www.minsa.gob.pe/reunis/) [5]. was accessed to obtain the number of diagnosed oral diseases in patients who visited MINSA facilities during 2021-2022, considering the patient's origin in outpatient care, age group, and department of Peru.

Next, search terms to include in the study were selected based on previous research on search trends related to oral health [13,14] and the most common oral diseases identified by WHO [15,16]. The final selection of terms considered those with the highest RSV within each thematic area.

Then, the GT portal(https://trends.google.com/trends/) [7] was accessed to identify the RSV for the selected terms, grouped into five thematic areas (Table 1).

Table 1. Oral health terms included in the study.

Thematic area	Search terms
Dental Caries	"dental caries"; "carious lesion"; "decayed tooth"; "cavity"; caries
Periodontal Diseases	gingivitis; periodontitis; "gum bleeding"; "red gums"; "pyorrhea"
Dental Malocclusion	"malocclusion"; "crooked teeth"; "dental malocclusion"; "bad bite"; "misaligned teeth"
Tooth Loss	"tooth loss"; "missing teeth"; "no teeth"; "edentulous"; "edentulism"
Dental Wear	"dental wear"; "dental erosion"; "dental attrition"; "dental abfraction"

The results provided by GT were downloaded in a normalized comma-separated values (CSV) format and transferred to a Microsoft Excel® 2020 spreadsheet for further processing. Data collection was independently performed by two authors. In cases of discrepancies, these were resolved through consensus with a third author.

Statistical Analysis

A quality control of the data was performed through double entry, with inconsistencies corrected by consensus between two independent researchers. Statistical analysis was conducted using Stata v.14 software. Descriptive analysis included the use of frequency and percentage measures. To evaluate the relationship between RSV and oral health morbidity, the Spearman correlation coefficient was applied, as the variables did not meet normality assumptions. The association was evaluated monthly throughout the 2021-2022 period across all of Peru.

Ethical Considerations

This study was submitted to the Integrated Unit for Research Management, Science, and Technology of the Faculties of Medicine, Dentistry, and Nursing, evaluated, and approved by the Institutional Ethics Committee of the Universidad Peruana Cayetano Heredia (CIE-UPCH). Since publicly accessible databases such as GT and REUNIS were used, no personal data privacy or confidentiality was compromised. The availability and transparency of these sources support the reliability of the results obtained.

RESULTS

It was found that the number of oral health disease cases treated through outpatient services was higher among rural populations. For dental caries, 62.25% (n = 1,530,004) of the cases were from rural areas; for periodontal diseases, 51.72% (n = 281,572); and for tooth loss, 72.00% (n = 163,128). In contrast, dental malocclusion cases were more frequent in urban areas, representing 71.94% (n = 39,260) of the total (Table 1).

Table 1. Distribution of Oral Health Disease Cases in Peru, 2021-2022, by Area of Origin in Outpatient Care, according to data from the National Unified Repository of Health Information – REUNIS.

Oral health disease	2021				2022				Total			
	Urban		Rural		Urban		Rural		Urban		Rural	
	n	%	n	%	n	%	n	%	n	%	n	%
Dental caries	297 020	32.68	611 795	67.32	630 617	40.71	918 209	59.29	927 637	37.75	1 530 004	62.25
Periodontal diseases	90 494	41.70	126 468	58.30	172 359	52.63	155 104	47.37	262 853	48.28	281 572	51.72
Dental malocclusion	11 096	66.97	5 471	33.03	28 164	74.10	9 842	25.90	39 260	71.94	15 313	28.06
Tooth loss	20 287	23.49	66 066	76.51	43 158	30.77	97 062	69.23	63 445	28.00	163 128	72.00

REUNIS: National Unified Repository of Health Information.

Regarding the total number of cases by age group, dental caries was the most prevalent disease in all groups: children (83.95%), adolescents (77.11%), young adults (71.90%), adults (68.98%), and older adults (56.20%). The most affected age group was children, with a total of 1,085,099 reported cases of oral health diseases (Figure 1).

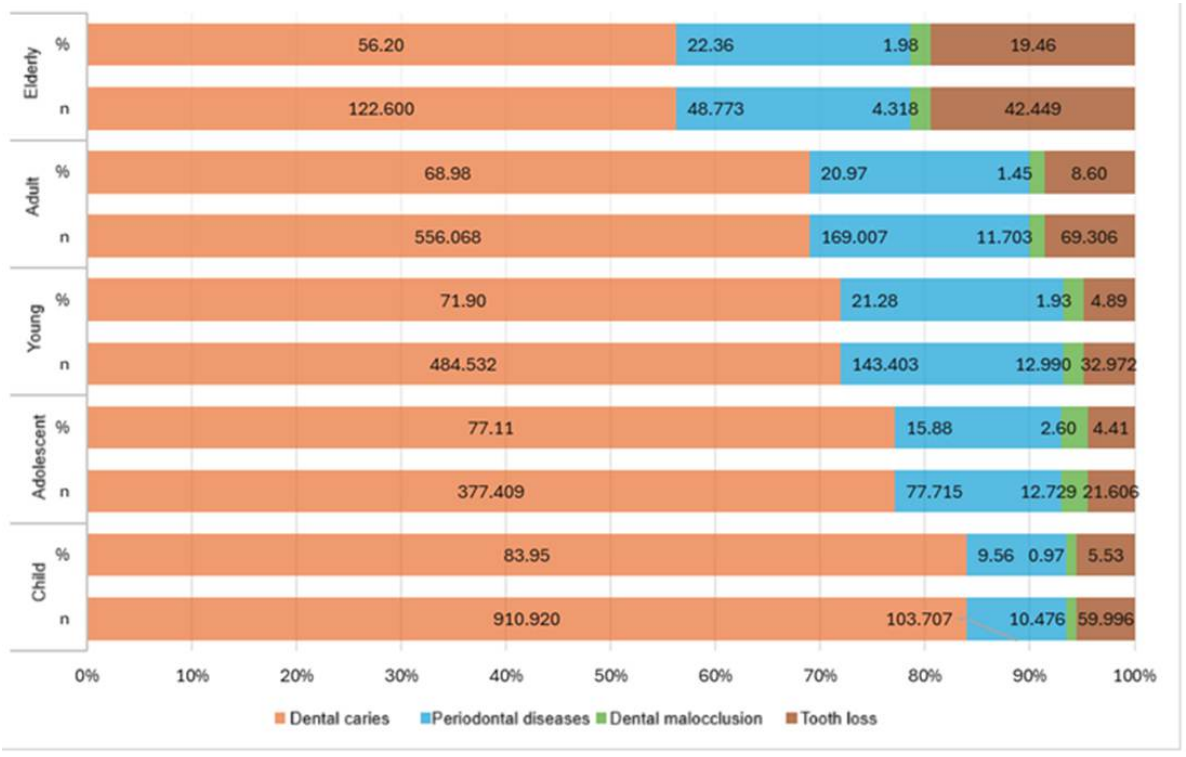

Figure 1. Distribution of Oral Health Disease Cases in Peru, 2021-2022, by Age Group, according to data from the National Unified Repository of Health Information – REUNIS.

At the departmental level, all regions of the country reported dental caries as the leading cause of consultation. Lima was the region with the highest number of registered cases: dental caries (n = 470,951), periodontal diseases (n = 149,336), dental malocclusion (n = 18,809), tooth loss (n = 27,502), and dental wear (n = 82,206). dental caries, 30,831 of periodontal diseases, 1,241 of dental malocclusion, 13,582 of tooth loss, and 24,344 of dental wear (Table 2).

Table 2. Distribution of Oral Health Disease Cases in Peru, 2021-2022, by Department, according to data from the National Unified Repository of Health Information – REUNIS.

Department	Dental caries		Periodontal diseases		Dental malocclusion		Dental loss		Dental wear		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Amazonas	46 465	65.40	9 355	13.17	319	0.45	9588	13.50	5320	7.49	71047	2.04
Ancash	117 635	54.45	41 248	19.09	15 960	7.39	13 698	6.34	27 506	12.73	216 047	6.20
Apurímac	76 511	73.53	6 857	6.59	261	0.25	13 065	12.56	7 358	7.07	104 052	2.99
Ayacucho	91 073	79.70	11 947	10.46	1 399	1.22	6 147	5.38	3 704	3.24	114 270	3.28
Cajamarca	173 356	71.24	30 831	12.67	1 241	0.51	13 582	5.58	24 344	10.00	243 354	6.99
Callao	29 851	63.35	10 522	22.33	788	1.67	1 788	3.79	4 170	8.85	47 119	1.35
Cusco	156 752	60.93	49 875	19.39	1 081	0.42	8 585	3.34	40 990	15.93	257 283	7.39
Huancavelica	101 083	75.99	10 821	8.13	535	0.40	10 934	8.22	9 653	7.26	133 026	3.82
Huánuco	137 846	69.46	29 915	15.07	594	0.30	9 783	4.93	20 318	10.24	198 456	5.70
Ica	67 485	80.01	8 111	9.62	474	0.56	3 275	3.88	4 996	5.92	84 341	2.42
Junín	151 352	71.17	31 073	14.61	1 488	0.70	15 925	7.49	12 819	6.03	212 657	6.11
La Libertad	64 451	63.84	20 610	20.41	1 486	1.47	4 511	4.47	9 899	9.81	100 957	2.90
Lambayeque	40 773	66.58	7 481	12.22	951	1.55	4 945	8.08	7 085	11.57	61 235	1.76
Lima	470 951	62.89	149 336	19.94	18 809	2.51	27 502	3.67	82 206	10.98	748 804	21.50
Loreto	135 809	69.71	33 108	16.99	535	0.27	5 614	2.88	19 761	10.14	194 827	5.59
Madre de Dios	19 235	73.04	2 458	9.33	156	0.59	2 301	8.74	2 185	8.30	26 335	0.76
Moquegua	19 076	69.38	3 042	11.06	269	0.98	3 503	12.74	1 604	5.83	27 494	0.79
Pasco	16 764	84.14	1 279	6.42	26	0.13	1 003	5.03	853	4.28	19 925	0.57
Piura	94 483	65.80	16 408	11.43	1 548	1.08	14 246	9.92	16 907	11.77	143 592	4.12
Puno	143 787	75.10	10 525	5.50	757	0.40	25 433	13.28	10 950	5.72	191 452	5.50
San Martin	90 989	70.62	18 250	14.16	1 775	1.38	5 739	4.45	12 088	9.38	128 841	3.70
Tacna	32 672	64.41	6 340	12.50	140	0.28	5 359	10.57	6 211	12.25	50 722	1.46
Tumbes	31 252	69.39	6 076	13.49	118	0.26	2 348	5.21	5 242	11.64	45 036	1.29
Ucayali	40 248	64.81	8 741	14.07	179	0.29	7 541	12.14	5 396	8.69	62 105	1.78

Regarding search terms, it was found that for the category of dental caries, the most searched term was "caries," followed by "decayed tooth," "dental caries," "carious lesion," and "decayed tooth." An increase in the search frequency for the terms "caries" and "dental caries" was observed starting in January 2022. Regarding periodontal diseases, the most searched term was "gingivitis," followed by "periodontitis," "red gums," "gum bleeding," and "pyorrhea."

The relative search volume (RSV) for these terms showed an irregular pattern over time. For terms related to dental malocclusion, the most searched term was "malocclusion," followed by "crooked teeth," "dental malocclusion," "bad bite," and "misaligned teeth."

The terms "malocclusion," "crooked teeth," and "dental malocclusion" reached an RSV of 100. In the category of tooth loss, the most searched term was "toothless," followed by "edentulous," "edentulism," "missing teeth," and "tooth loss." For the category of dental wear, the most searched term was "dental wear"; in contrast, "dental erosion" and "dental abfraction" had significantly lower search values (Figure 2).

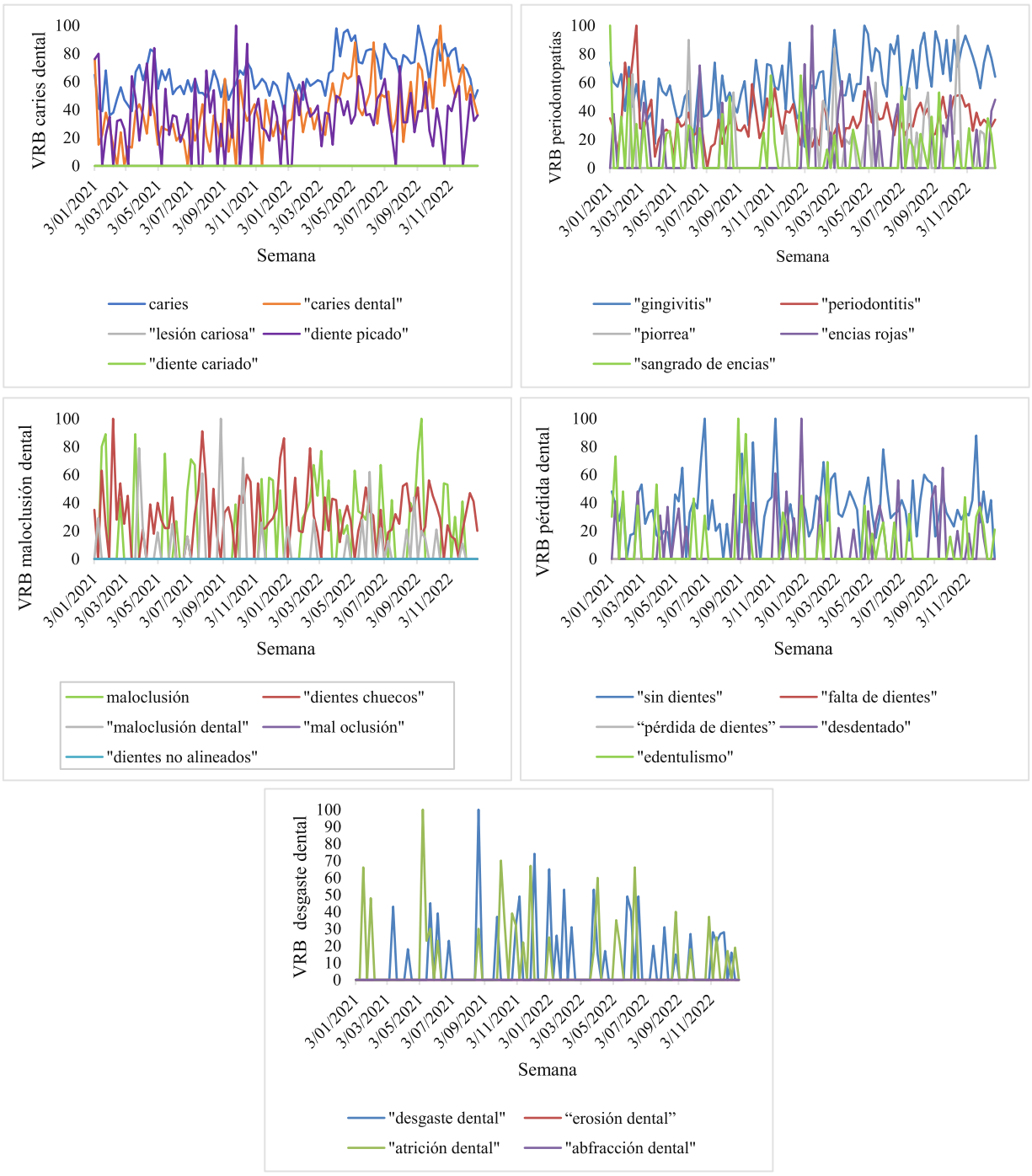

Figure 2. Relative Search Volume on Oral Health-Related Terms in Peru, 2021-2022, according to Google Trends data.

In the Spearman correlation analysis between the RSV of the terms and the monthly number of diagnosed cases, a strong positive and statistically significant correlation was found between the RSV for dental caries and its number of cases (Spearman's rho = 0.751; p-value = 0.001). In contrast, very low and non-significant positive correlations were observed between the RSV and cases of dental wear (Spearman's rho = 0.176; p-value = 0.412), tooth loss (Spearman's rho = 0.241; p-value = 0.257), and dental malocclusion (Spearman's rho = 0.142; p-value = 0.507) (Figure 3).

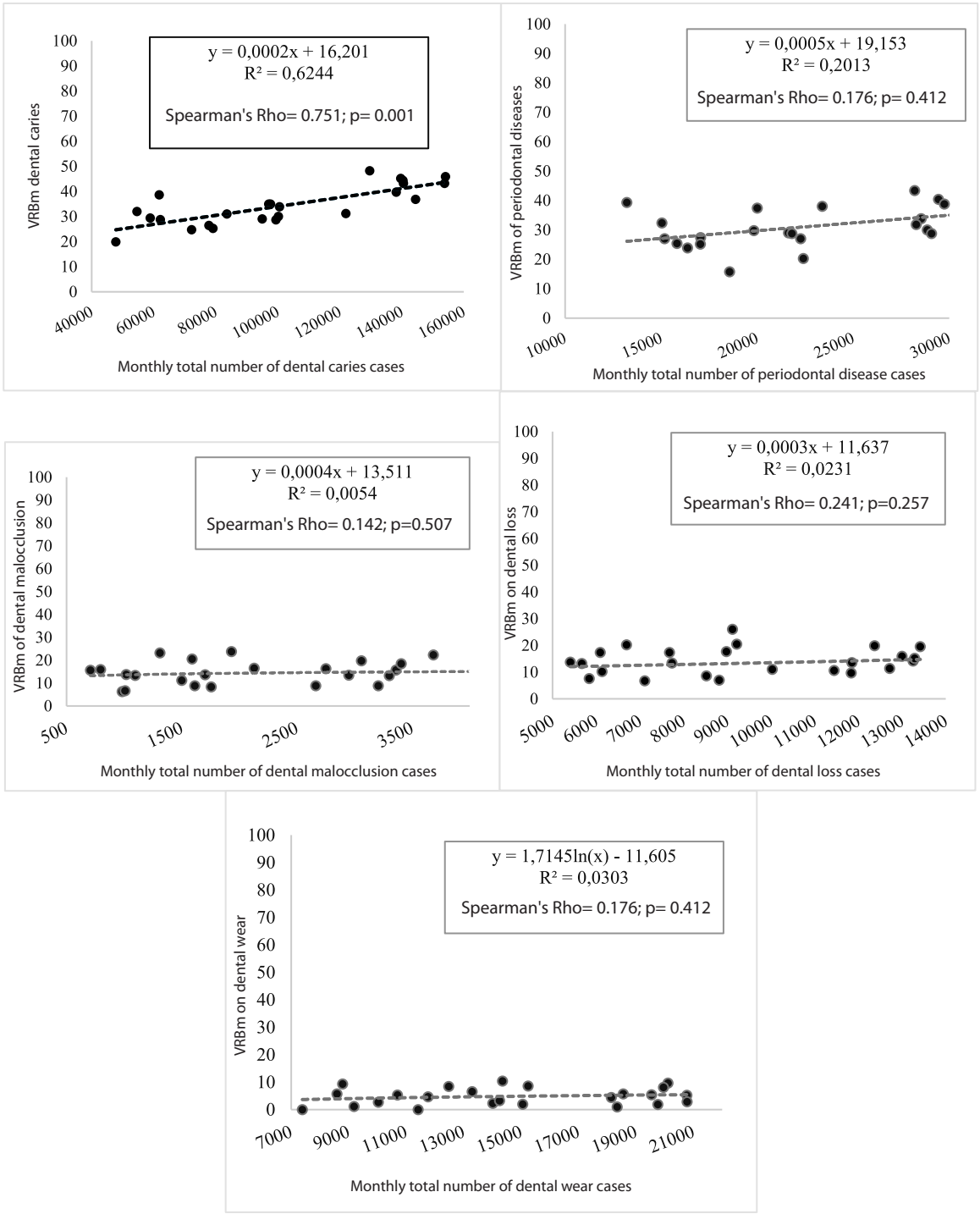

Figure 3. Association between Oral Health Morbidity and Internet Search Interest in Peru, 2021-2022, according to data from the National Unified Repository of Health Information – REUNIS and Google Trends.

DISCUSSION

Oral diseases have a global prevalence of 45% [2], affecting developing countries such as Peru more frequently. In this context, establishing an oral health surveillance system is a priority [17]. In recent years, Google Trends (GT) has gained relevance in health surveillance due to its ability to track and analyze internet search trends. This tool allows for the detection of outbreaks and emerging diseases, monitoring their spread, comparing search patterns with epidemiological data, and evaluating the impact of public health interventions [18].

An example of this is the significant increase in interest in searches related to toothaches following the COVID-19 outbreak[19]. According to the latest WHO oral health report, the most common pathologies include dental caries, severe periodontitis, tooth loss, and oral cancer [2]. In this study, dental caries was the most prevalent disease, followed by periodontal diseases, tooth loss, and malocclusion. These pathologies have been associated with social inequality factors in the literature, as they mainly affect vulnerable populations[2].

Regarding place of residence, a higher prevalence of oral diseases was observed in rural areas, which may be related to limited access to healthcare services compared to urban areas. This finding is consistent with previous studies reporting greater barriers to accessing dental services in rural populations[20,21]. On the other hand, malocclusions were the least frequent pathologies, possibly because, in the country's public healthcare system, diagnosis is the primary service available for this condition. This contrasts with countries like Brazil, where the Unified Health System finances orthodontic treatments[22].

Our study showed an increase in oral health morbidity during 2022, which may be associated with the increased flow of patients to MINSA's dental services after the reduction of COVID-19 restrictions. These findings are consistent with previous research[23].

Oral diseases affect all age groups, although their distribution varies by age group. Globally, dental caries has a prevalence of 43% in deciduous teeth and 29% in permanent teeth[2]. In this study, this pathology was the most common across all age groups, with a higher incidence in children. This could be explained by a lack of brushing skills in early life stages and limited access to oral hygiene materials in low-resource populations. A study by Van N et al. found significant differences in the prevalence of caries between children with and without good oral health knowledge, attitudes, and practices (p-value < 0.010) [24]. Childhood represents a key opportunity to establish healthy habits that help reduce the burden of oral diseases in later stages of life. Additionally, the lack of knowledge among parents or caregivers regarding the importance of early oral care should be considered[25].

In older adults, tooth loss was the predominant condition, which may be attributed to limited access to healthcare services, lack of knowledge about prevention, and absence of timely treatment for prior conditions such as caries and periodontal disease. King S et al. reported that 71% of participants in their study (average age of 68 years) had non-functional dentition (less than 20 teeth), associated with low oral health literacy and economic barriers to accessing dental services[26].

Malocclusions were more frequent in adolescents and young adults, which may be due to greater concern for aesthetics and oral health during these life stages. Moreover, this population group has greater access to information about these pathologies and their treatment. These findings align with the study by Lombardo G et al., which showed a high prevalence of malocclusions during childhood and adolescence [27]. Furthermore, Göranson E et al. noted that malocclusions in adolescents negatively affect their oral health-related quality of life[28].

Oral diseases show an uneven distribution both globally and within countries, with lower-income populations being more affected [2]. According to REUNIS, Lima was the department with the highest oral health morbidity in Peru, followed by Cusco and Cajamarca. In contrast, Pasco, Madre de Dios, and Moquegua recorded the lowest rates. These differences may be explained by variability in population density, the availability of MINSA dental services, and local authorities' commitment to promoting oral health [29]. Our study also revealed that most Peruvians searched for dental caries-related terms within the group of oral diseases. This finding could be explained by the high prevalence of this disease in Peru and worldwide, which increases users' interest in obtaining information[30].

Regarding the relative search volume (RSV) values, the most searched term was "caries," in contrast to previous studies identifying "tooth decay" as the term with the highest RSV worldwide [11,31].

In the case of periodontal diseases and tooth loss, the most searched terms were "gingivitis" and "toothless," respectively, in accordance with previous studies [11,31].

A correlation was identified between the RSV for dental caries and the number of reported cases by MINSA, which is consistent with the findings by Lotto M et al., who found an association between RSV for dental pain and the number of dental consultations for this reason in the United States (β = 14.12; 95% CI = 6.59-21.64; p = 0.006), as well as with the number of emergency dental treatments (β = 3.48; 95% CI = 0.60-6.37; p = 0.026) [32].

This behavior could be explained by the growing trend of people searching for information about their health status on the internet. The ease of access to updated information, the ability to identify symptoms and obtain a preliminary diagnosis, as well as the opportunity to learn from other patients' experiences, may influence this phenomenon [33,34]. However, other studies have explored the association between RSV for oral health topics and non-epidemiological factors. For example, Büyükçavuş MH et al. found a correlation between the RSV for orthodontic terms and gross domestic product in 26 countries, although without statistical significance (p > 0.050) [35].

This research has some limitations. First, not all Peruvians have access to the internet (25–30%), so it is possible that the total online search interest was not captured. Second, the country's linguistic diversity may have influenced the selection of terms, preventing the accurate reflection of actual search interest. Finally, this study relied exclusively on GT data, which may limit the capture of trends from other search engines.

CONCLUSION

Our study found that the RSV for dental caries was the only term that showed a strong statistical correlation and was associated with the number of dental caries-related consultations at MINSA facilities in Peru.

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