

## Article

# Oral and Dental Needs and Teledentistry Applications in the Elderly: Real-Time Surveillance Using Google Trends

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**Featured Application:** The present cross-sectional analysis aimed to evaluate the level of interest in oral and dental needs and teledentistry applications among the elderly, as well as whether COVID-19 pandemic outbreaks were influenced by real-time surveillance, using Google Trends. As the number of elderly dental patients continues to increase, there is a growing need for specific interventions that address the biological and psychological issues of this population. Teledentistry represents a healthcare delivery system that can overcome these problems, although the oral and dental care provision methods involved are still unknown to most people. Indeed, there is a need to raise awareness of the indications for teledentistry, the available interventions, and the potential benefits for the oral and dental care of elderly patients.

**Abstract:** Considering the increasing need for oral and dental care in the elderly, teledentistry has been proposed to improve the education of elderly patients in oral health maintenance and risk factor control, identify patients' concerns in advance, facilitate monitoring, and save time and money. The present cross-sectional analysis of Google search data through real-time surveillance with Google Trends aimed to determine Google users' interest in oral and dental needs and teledentistry applications in the elderly, and to compare search volumes before and after the COVID-19 outbreak. Extracted CVS data were qualitatively analyzed. Pearson and Spearman correlation analyses were performed between searches for "elderly" and "teledentistry", and all the oral and dental needs and teledentistry applications. The Mann–Whitney U test compared search volumes in the 36 months before and after the beginning of the COVID-19 pandemic. Google users' interest in the elderly and related oral and dental needs was diffusely medium–high, while teledentistry and its applications were of lower interest. Interest in teledentistry and its applications was strongly related to interest in the older population, which is consistent with the assumption that older adults represent the population segment that could benefit most from these tools. A positive correlation was also found between searches for "Elderly" and searches for almost all oral and dental needs typical of the geriatric population. Search volumes increased significantly after the outbreak of the COVID-19 pandemic. More information about teledentistry should be disseminated to increase knowledge and awareness, especially among older patients, about its indications, applications, and advantages.

**Keywords:** teledentistry; remote dentistry; m-health; mobile health; dental application; dental app; (tele)consultation; (tele)diagnosis; (tele)assistance; (tele)support; (tele)screening; (tele)monitoring; education; "elderly"; "aged"; "older"; "elder"; "geriatric"; "nursing homes"; "nursing home"; "long term care"; "residential care"; "home assistance"; toothache; tooth loss; periodontitis; caries; dentures; stomatitis; tooth extraction; oral care; dental care



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## 1. Introduction

Medical advances have lowered mortality rates, and today, an estimated 1 in 11 people are 65 years of age or older, with a steady increase in the elderly population [1–4]. As a result, the need for oral and dental care in older patients has increased [5]. The natural aging process can lead to oral pathologies in the elderly due to age-related involutational physiological changes. Additionally, systemic diseases and conditions can affect oral health, and vice versa, as evident in elderly patients who have a higher prevalence of both systemic and oral diseases due to the physiological effects of advancing age [5]. In this vulnerable population, age-related pathologies and functional impairments should be considered to ensure the effectiveness and safety of oral and dental care, especially in the elderly with psychomotor deficits [5]. Indeed, elderly individuals with depression or dementia may experience challenges in accessing dental care, particularly in a supine position. In addition, cognitive decline, disability, and various unhealthy lifestyles—especially smoking, but also improper oral hygiene habits and alcohol consumption—also influence oral, dental, and periodontal needs and the overall oral health of the geriatric population [6].

Oral health plays a fundamental role in achieving and maintaining general health, especially in the elderly [7]. The general health of older people results from several interdependent factors, such as physical performance, cognitive and affective state, and the person's social and self-image, as defined by the WHO [5].

Accordingly, geriatric dentistry may also take on a special social significance, as the health of elderly patients is affected by both biological and psychosocial problems, and oral and dental care provision should be adapted to the specific needs of elderly patients [1]. In this regard, teledentistry has been proposed for improving older patients' awareness and education concerning oral health maintenance and risk factor control. In addition, teledentistry may aid in preliminarily identifying patients' concerns, facilitating monitoring, and saving time and money [2].

Teledentistry provides the delivery of dental services, including consultations (teleconsultation); assistance (teleassistance); diagnosis (telediagnosis); follow-ups and re-assessments (telemonitoring); management (teletreatment); screening (telescreening); and education and motivation reinforcement by healthcare professionals, at a distance, through information technology [8,9]. As the elderly population commonly experiences hearing and visual impairments and may not be familiar with the latest technologies, they may require assistance from family members or caregivers with data collection and transmission. This could potentially hinder the adoption of teledentistry, which has been proposed as a means of aiding dental care provision beyond hospitals, dental offices, and remote home treatment, particularly in nursing homes for the elderly [8]. Despite these challenges, a growing body of research supports teledentistry's potential benefits in improving access to care and enhancing oral health outcomes [8].

Several studies have shown that telemedicine, remotely delivering medical care, enhances access to care—especially for underserved populations not only living in remote areas, but also with disabilities [10–12]—as well as facilitates timely healthcare services provision and supports the remote monitoring and assistance of older patients suffering from diabetes and heart diseases [13]; however, teledentistry applications in the elderly have received little investigation [8]. Consequently, in addition to specific ethical and legal regulations, teledentistry provision methods, effectiveness, reliability, indications (oral and dental needs), applications (dental services), and, above all, geriatric dental patients' attitudes and interest [8] remain to be determined.

The Internet has become increasingly popular among people seeking health information [14], including the elderly [15,16]. In the last decade, about 70% of Internet users searched for health information online [17]. Notably, 50% of all online health searches were conducted on behalf of another person [17]. Among these, 77% of online health searchers used the Yahoo and Google search engines.

The Google Trends tool is a service freely available to the public, developed and operated by Google. It was launched in May 2006 and is updated daily [18,19]. This tool

was used to collect data on Internet search interest among Google search engine users [20]. Because Google Trends analyzes the popularity of Internet searches in different languages and regions around the globe [21,22], it has been used for surveillance, monitoring, and prevalence studies; for epidemiological predictions by comparing the evidence found in the number of clicks on a link triggered by a keyword in Google [23,24]; and for assessing the interest and attitudes [20,25] of Internet users.

Considering that the amount of medical information retrieved and shared from the Internet via websites and social media is constantly increasing, the primary aim of the present study was to determine the level of interest in Google searches for oral and dental needs and teledentistry applications among the elderly through real-time surveillance using Google Trends [20]. Since teledentistry became more widespread during the COVID-19 pandemic [9,20,26], even leading to an expansion in the related oral and dental needs and applications, the present study secondarily aimed to compare teledentistry needs and applications in the elderly search volumes in the 36 months before and after the COVID-19 outbreak.

## 2. Materials and Methods

### 2.1. Study Design

A cross-sectional analysis of data from Google searches was performed using the Google Trends tool. All data were anonymous, public, and freely available on a daily basis [18–20]; therefore, no ethics committee approval was required.

### 2.2. Search Strategy

Internet searches from Google users were evaluated worldwide and in English-speaking countries, so search terms were restricted to the English language.

The most common Internet search terms concerning the geriatric population and remote oral and dental care were identified through Google Trends among the following keywords and the associated queries [27]:

- Geriatric, elderly, aged, older, elder, nursing homes, nursing home, long term care, residential care, and home assistance;
- Teledentistry, m-health, mobile health, dental application, dental app.

Common oral and dental needs in the elderly [1,5,28,29] were searched using the following keywords: tooth loss, periodontitis, caries, dentures, stomatitis, and tooth extraction.

Potential teledentistry applications for geriatric oral and dental care were searched using the following keywords: (tele)consult, (tele)diagnosis, (tele)assistance, (tele)screening, (tele)monitoring, and education.

Search volumes of identified Google Trends search terms were tested alone in the case of “Teledentistry” and “Elderly”, and later combined by a plus sign “+” to show the association of “Teledentistry” and “Elderly” with the identified search terms [30] on oral and dental needs and teledentistry applications.

### 2.3. Data Collection and Extraction

Data concerning worldwide search volumes of identified Google Trends search terms concerning elderly, teledentistry, oral and dental needs, and teledentistry applications from Google search engine users, were collected from the Google Trends tool [25], from 1 January 2004 (first date on which data were available) to 31 December 2022.

Since the website normalizes Google searches in a selected location and timeframe [25] in a range between 0, indicating the minimum number, and 100, the maximum number of searches [30], the so-called relative search volumes (RSV) for the search terms on the Internet worldwide were obtained as graphs for visualization and CVS data for further analysis [25].

Search categories were not selected, since the search terms and keywords employed were specific and unequivocal [25].

## 2.4. Data Analysis

The extracted CVS data were qualitatively analyzed; values  $<1$  were computed as 0.5 [25]. A Shapiro–Wilk test was used in the assessment of the data for normal distribution. A Pearson correlation analysis was used when the data were normally distributed, and a Spearman correlation analysis was used when the data were not normally distributed between “elderly”, “teledentistry”, and all investigated oral and dental needs (tooth loss, periodontitis, caries, dentures, stomatitis, tooth extraction), and between “elderly”, “teledentistry”, and all investigated teledentistry applications (consult, diagnosis, monitoring, screening, assistance, and education) [31].

Descriptive statistics and the Mann–Whitney U test compared search volumes in the 36 months before and after the beginning of the COVID-19 pandemic (January 2020) [31].

The statistical significance level was accepted as  $p < 0.05$ .

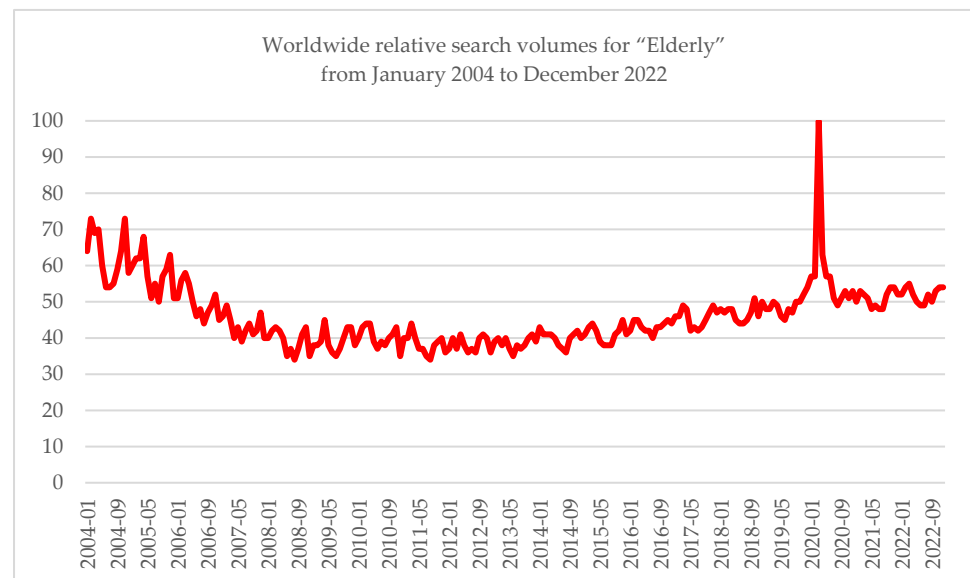
## 3. Results

### 3.1. Google Trends Relative Search Volumes for “Elderly” and “Teledentistry”

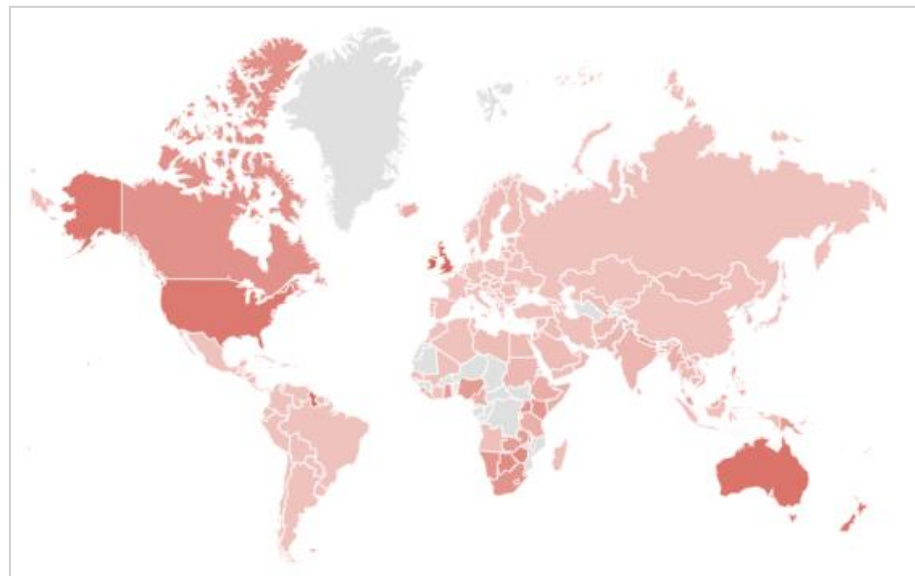
The most relevant search term for the geriatric population was “Elderly”, as per Google Trends.

Worldwide relative search volumes for “Elderly” from January 2004 to December 2022 showed diffusely medium–high normalized values, with a peak between January and September 2020, and a wide geographical distribution, mainly involving Singapore with the maximum interest (RSV = 100), followed by Ireland (RSV = 62), Jamaica (RSV = 61), United Kingdom (RSV = 53), Australia (RSV = 46), and others. The regions with the lowest interest for the “Elderly” search term (RSV = 1) were Mexico, Brazil, Germany, France, Japan, Turkey, Russia, Poland, New Zealand, the United States, and Hong Kong.

Worldwide relative search volumes for “Elderly” until 31 December 2022 and the related geographic distribution are illustrated in Figures 1 and 2.



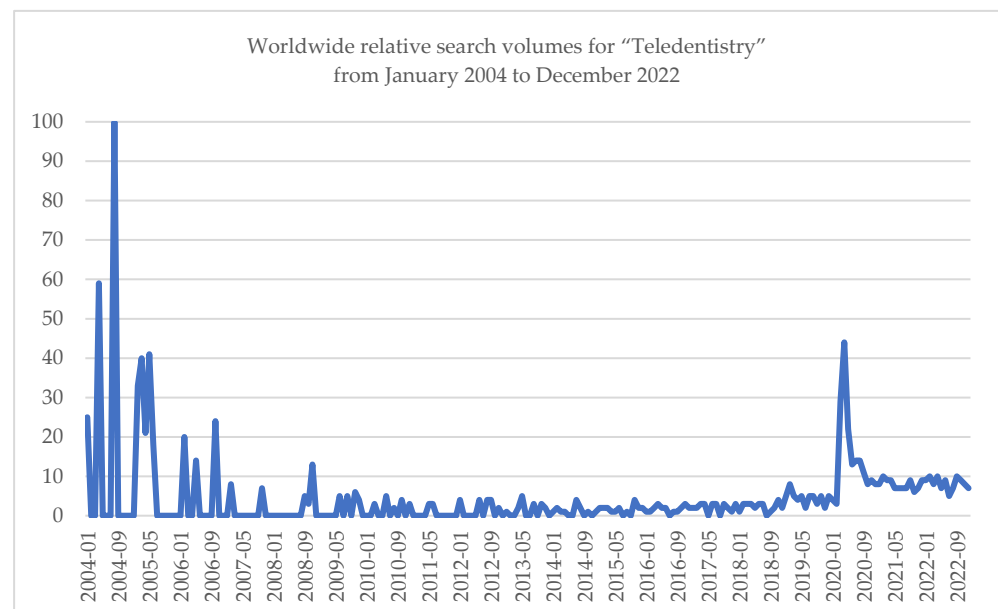
**Figure 1.** Worldwide relative search volumes for “Elderly” from January 2004 to December 2022.



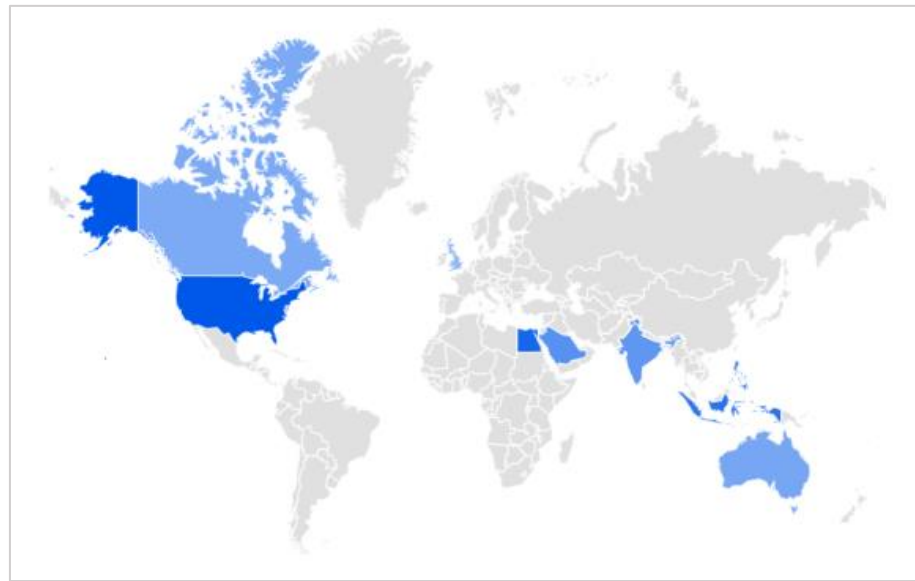
**Figure 2.** Worldwide interest by region for “Elderly” search term on Google search engine.

The most relevant search term for remote dental care provision was “Teledentistry”, as per Google Trends.

Worldwide relative search volumes for “Teledentistry” from January 2004 to December 2022 (Figure 3) showed a higher peak in September 2004 and lower ones in 2005, 2006, and between January and September 2020. They also showed limited geographical distribution, involving the United States with the maximum interest (100 RSV), followed by Egypt (RSV = 76); Indonesia (RSV = 75); Philippines (RSV = 67); India (RSV = 44); Australia (RSV = 39); Canada (RSV = 33); Saudi Arabia (RSV = 32); and the United Kingdom (RSV = 19). No Google search data from other countries were recorded (Figure 4).



**Figure 3.** Worldwide relative search volumes for “Teledentistry” from January 2004 to December 2022.



**Figure 4.** Worldwide interest by region for “Teledentistry” search term on Google search engine.

### 3.2. Google Trends Relative Search Volumes for “Elderly” and “Teledentistry” Combined with Oral and Dental Needs, or Teledentistry Applications

The keywords “Tooth loss”, “Periodontitis”, “Tooth extraction”, “Dentures”, “Caries”, and “Stomatitis” for oral and dental needs were all relevant search terms concerning oral and dental needs, as per Google Trends.

A poor match was found instead for the keywords “teleconsult”, “telediagnosis”, “teleassistance”, “telescreening”, and “telemonitoring” for remote oral and dental care, thus replaced by “Consult”, “Diagnosis”, “Monitoring”, “Screening”, “Assistance”, and “Education”.

“Elderly” RSV mean and median RSV values were 45.579 and 44.000, respectively, while those related to “Teledentistry” were 0.303 and 0.5, overall indicating a very limited interest in the last.

Higher RSV was recorded in potential teledentistry applications in the elderly rather than the oral and dental needs of the geriatric population. In detail, the strongest interest of Internet users was focused on “Assistance” (mean RSV = 70.751; median RSV = 70); “Education” (mean RSV = 45.218; median RSV = 39); and “Diagnosis” (mean RSV = 41.013; median RSV = 39).

Among the oral and dental needs diffused among the geriatric patients and presently investigated, “Dentures” (mean RSV = 10.105; median RSV = 9) and “Tooth extractions” (mean RSV = 8.461; median RSV = 7.000) were the most frequently inquired, opposite to “Stomatitis” (mean RSV = 2.250; median RSV = 2) and “Periodontitis” (mean RSV = 2.566; median RSV = 2), revealing the lowest public interest.

The descriptive statistics of normalized RSV values between January 2004 and December 2022 for “Elderly”, “Teledentistry”, oral and dental needs, and potential teledentistry applications are illustrated in Table 1.

### 3.3. Correlation between Worldwide Google Trends Relative Search Volumes (RSV) for “Elderly” and “Teledentistry” Combined with Oral and Dental Needs, or Teledentistry Applications

Teledentistry ( $r = 0.214$ ;  $p$  value = 0.001), Tooth extraction ( $r = 0.207$ ;  $p$  value = 0.002); and Consult ( $r = 0.214$ ;  $p$  value = 0.001) RSVs were positively correlated.

Periodontitis ( $r = 0.508$ ;  $p$  value < 0.001), Dentures ( $r = 0.234$ ;  $p$  value < 0.001), Caries ( $r = 0.580$ ;  $p$  value < 0.001), and Stomatitis ( $r = 0.505$ ;  $p$  value < 0.001), among the oral and dental needs common in the elderly; and Diagnosis ( $r = 0.637$ ;  $p$  value < 0.001), Monitoring ( $r = 0.470$ ;  $p$  value < 0.001), Screening ( $r = 0.496$ ;  $p$  value < 0.001), Assistance ( $r = 0.333$ ;  $p$  value < 0.001), and Education ( $r = 0.376$ ;  $p$  value < 0.001), among the potential teledentistry applications, were strongly correlated with the Elderly search throughout Google.



**Table 1.** Descriptive statistics of worldwide relative search volumes for “Teledentistry”, “Elderly”, oral and dental needs, and Teledentistry applications from January 2004 to December 2022.

Worldwide Relative Search Volumes	Mean	Lower	Upper	Median	SD <sup>1</sup>	IQR <sup>2</sup>	Minimum	Maximum
Teledentistry	0.303	0.270	0.336	0.500	0.254	0.500	0.000	1.00
Elderly	45.579	44.462	46.696	44	8.559	11.000	34	100
Oral and dental needs								
Tooth loss	0.919	0.895	0.943	1	0.185	0.000	0.500	1.00
Periodontitis	2.566	2.482	2.650	2	0.644	1.000	2	5
Tooth extraction	8.461	7.830	9.091	7	4.835	9.000	2	19
Dentures	10.105	9.596	10.614	9	3.900	7.000	5	19
Caries	7.193	7.031	7.355	7	1.244	2.000	5	11
Stomatitis	2.250	2.188	2.312	2	0.473	0.000	2	4
Teledentistry applications								
Consult	15.886	15.057	16.716	13	6.373	8.000	8	42
Diagnosis	41.013	40.121	41.906	39	6.855	7.000	30	62
Monitoring	4.153	3.998	4.308	4	1.191	1.000	3	8
Screening	3.000	2.922	3.078	3	0.600	0.000	2	5
Assistance	70.751	69.490	72.012	70	9.684	14.000	55	100
Education	45.218	43.137	47.299	39	15.981	15.000	28	100

Abbreviations: <sup>1</sup> SD: standard deviation; <sup>2</sup> IQR: interquartile range.

**Table 2.** Correlation between the worldwide relative search volumes for “Elderly”, “Teledentistry”, oral and dental needs, and teledentistry applications, computed through Pearson’s correlation test.

Elderly RSV	Teledentistry RSV	Oral needs and concerns RSV					
		Tooth loss	Periodontitis	Tooth extraction	Dentures	Caries	Stomatitis
Pearson’s r	0.214 **	0.017	0.508 ***	0.207 **	0.234 ***	0.580 ***	0.505 ***
p-value	0.001	0.795	<0.001	0.002	<0.001	<0.001	<0.001
95% CI Upper	0.335	0.147	0.599	0.328	0.353	0.660	0.596
95% CI Lower	0.087	−0.113	0.405	0.079	0.107	0.486	0.402
		Teledentistry applications RSV					
		Consult	Diagnosis	Monitoring	Screening	Assistance	Education
Pearson’s r	0.090	0.214 **	0.637 ***	0.470 ***	0.496 ***	0.333 ***	0.376 ***
p-value	0.175	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
95% CI Upper	0.217	0.334	0.708	0.565	0.588	0.444	0.482
95% CI Lower	−0.040	0.087	0.552	0.362	0.392	0.213	0.259

Note. \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ .

Tooth loss ( $r = 0.017$ ;  $p$  value = 0.795) was the only Google Trends RSV not correlated with the Elderly one.

Correlation between Worldwide Google Trends RSV for “Elderly” and “Teledentistry” Combined with Oral and Dental Needs, or Teledentistry Applications are detailed in Table 2.

### 3.4. Comparison between Google Trends Relative Search Volumes for “Elderly” and “Teledentistry” Combined with Oral and Dental Needs, or Teledentistry Applications

Worldwide RSVs concerning teledentistry, elderly, oral and dental concerns, and potential teledentistry (Table 3) applications generally increased in the 36 months following

the COVID-19 outbreak, except for Monitoring (mean RSV = 3.694 and median RSV = 4 before January 2020 vs. mean RSV = 3.861 and median RSV = 4 after January 2020).

**Table 3.** Worldwide relative search volumes on the Internet for “Teledentistry”, “Elderly”, oral needs and concerns, and teledentistry applications 36 months before and after the COVID-19 outbreak.

Worldwide Relative Search Volumes	36 Months before the COVID-19 Outbreak				36 Months after the COVID-19 Outbreak			
	Mean	Median	SD <sup>1</sup>	SE <sup>2</sup>	Mean	Median	SD <sup>1</sup>	SE <sup>2</sup>
Teledentistry	0.472	0.500	0.116	0.0194	0.500	0.500	0.000	0.0000
Elderly	2.972	3.000	0.167	0.0278	3.111	3.000	0.523	0.0871
Oral needs and concerns								
Tooth loss	1.000	1.000	0.000	0.0000	0.986	1.000	0.083	0.0139
Periodontitis	2.944	3.000	0.232	0.0387	3.444	3.000	0.558	0.0930
Tooth extraction	13.306	13.000	1.618	0.2697	16.222	17.000	2.085	0.3476
Dentures	14.361	14.000	1.246	0.2076	15.972	16.000	1.558	0.2597
Caries	7.083	7.000	0.649	0.1082	8.222	8.000	1.198	0.1996
Stomatitis	2.361	2.000	0.487	0.0812	2.417	2.000	0.500	0.0833
Teledentistry applications								
Consult	10.806	11.000	0.668	0.1114	11.611	12.000	0.964	0.1607
Diagnosis	40.361	40.500	3.893	0.6488	44.444	44.000	5.882	0.9803
Monitoring	3.694	4.000	0.467	0.0779	3.861	4.000	0.351	0.0585
Screening	3.000	3.000	0.239	0.0398	3.611	3.500	0.688	0.1146
Assistance	63.111	62.500	5.203	0.8672	75.000	73.500	7.018	1.1697
Education	35.111	35.000	3.328	0.5546	36.444	35.500	5.634	0.9390

Abbreviations: <sup>1</sup> SD: standard deviation, <sup>2</sup> SE: standard error.

The lowest interest among Google users was for Teledentistry, Tooth loss, Stomatitis, and Screening, while the highest was for Dentures, Tooth extraction, Assistance, and Diagnosis, basically similar to the RSVs of the overall period.

Statistically significant ( $p < 0.001$ ) differences were found in worldwide RSV for the elderly combined with Periodontitis, Tooth extraction, Dentures, and Caries when comparing searches for oral and dental needs in the elderly conducted 36 months before and after the COVID-19 outbreak (Table 4).

**Table 4.** Comparison of worldwide relative search volumes for oral needs and concerns between 36 months before and 36 months after the COVID-19 outbreak, computed through the Mann–Whitney U test.

Worldwide Relative Search Volumes 36 Months before vs. 36 Months after the COVID-19 Outbreak		
Oral Needs and Concerns	Statistic	<i>p</i>
Teledentistry	594.0	0.082
Elderly	79.5	<0.001
Tooth loss	630.0	0.331
Periodontitis	357.0	<0.001
Tooth extraction	144.5	<0.001
Dentures	273.0	<0.001
Caries	278.0	<0.001
Stomatitis	612.0	0.636

Note.  $H_0: \mu_0 \neq \mu_1$ .

Statistically significant ( $p < 0.001$ ) differences were also noticed in Consult, Screening, and Assistance worldwide RSVs, among the potential teledentistry applications, before and after January 2020 (Table 5).



**Table 5.** Comparison of worldwide relative search volumes for teledentistry applications between 36 months before and 36 months after the COVID-19 outbreak, computed through the Mann–Whitney U test.

Worldwide Relative Search Volumes 36 Months before vs. 36 Months after the COVID-19 Outbreak		
Teledentistry Applications	Statistic	<i>p</i>
Teledentistry	612.0	0.160
Elderly	595.0	0.088
Consult	310.0	<0.001
Diagnosis	386.5	0.003
Monitoring	540.0	0.093
Screening	331.0	<0.001
Assistance	92.5	<0.001
Education	583.0	0.466

Note.  $H_0: \mu_0 = \mu_1$ .

#### 4. Discussion

As the elderly population continues to grow rapidly [3], providing appropriate interventions that meet the biological and psychological needs of older adults to improve their oral health has become particularly important to society [1,2].

Teledentistry allows patient care to be delivered remotely [32]; therefore, it has been suggested that its applications may be particularly suitable implements for overcoming biological and psychosocial problems in older people [2]. Specifically, teledentistry may enhance older patients' access to dental care, enable timely care management, and improve awareness and literacy regarding oral health and related care [2].

Currently, there is little literature on the use of teledentistry and its applications for the elderly population, and Internet search patterns can be very useful in understanding population behavior and interest in various health areas [25].

Therefore, the present cross-sectional study aimed to assess the level of interest in oral and dental needs and teledentistry applications among the elderly by analyzing Google search queries on these topics via Google Trends.

The results showed that there was medium–high interest worldwide in the search term “Elderly” throughout the study period (from January 2004 to December 2022), while searches for “Teledentistry” were limited (Table 1).

However, interest in teledentistry peaked in September 2004 and between January and September 2020, coinciding with the COVID-19 pandemic outbreak (Figure 3). Interestingly, the latter peak coincided with the progressive spread of the first and further waves of the COVID-19 pandemic worldwide. It is fair to say that the fear of contagion and the limitations of social contacts increased public interest in the remote care delivery model. Furthermore, Internet users' interest in teledentistry applications among the elderly was primarily focused on “Assistance”, “Education”, and “Diagnosis” (Table 1), while searches for oral and dental needs were associated with lower relative search volumes.

(Table 1), probably because of the major complexity of these terms, frequently used by specialists, with the greatest interest in “Dentures” and “Tooth Extractions”.

Upon analyzing the correlation between different relative search volumes, a significant positive correlation was observed between searches for “Elderly” and “Teledentistry”. Similarly, searches for potential teledentistry applications, including “Consult”, “Diagnosis”, “Monitoring”, “Screening”, “Assistance”, and “Education” were all strongly correlated with searches for “Elderly”. This finding suggests that interest in teledentistry and its applications is strongly related to interest in the older population, which is consistent with the assumption that older adults represent the segment of the population that could benefit most from these tools [2].

Additionally, a positive correlation was also found between searches for “Elderly” and searches for almost all oral and dental needs common in the geriatric population, including “Periodontitis”, “Dentures”, “Caries”, and “Stomatitis”, likely revealing that interest in oral and dental problems is partly related to interest in the needs of the elderly.

However, searches for “Tooth loss” were the only ones that did not correlate with searches for “Elderly”, although edentulism is a major problem among the elderly [29] and contributes to social awkwardness and isolation [5].

Worldwide Google searches related to teledentistry, the elderly, oral and dental needs, and almost all teledentistry applications showed a general increase in interest in these topics, especially after the COVID-19 pandemic outbreak (January 2020), with the exception of “Monitoring”. This result suggested an overall increase in health information-seeking during the COVID-19 pandemic, probably due to the delay of medical and dental treatments and the decrease in medical and dental consultancies, which led patients to turn to Internet searches to solve health-related problems [25].

However, the interest in teledentistry in particular has remained relatively low, aside from a slight increase during the acute phase of the COVID-19 pandemic, suggesting that patients still prefer direct contact with healthcare providers over remote care delivery models.

On the contrary, the interest in the elderly among Google users increased after the COVID-19 pandemic outbreak, likely due to their vulnerability to severe consequences from SARS-CoV-2 infection [33].

Regarding oral and dental needs diffused among the elderly population, while searches for “Tooth loss” and “Stomatitis” decreased after the pandemic outbreak, those for “Dentures” and “Tooth extraction” remained high. However, these Google search trends were consistent with those found before the COVID-19 pandemic outbreak.

Similarly, searches for teledentistry applications among the elderly remained consistent before and after the pandemic outbreak, with “Assistance” and “Diagnosis” being the most searched terms, and “Screening” the less searched one.

When comparing searches for oral and dental needs in the elderly in the 36 months before and after the COVID-19 outbreak, statistically significant differences were found in worldwide search volumes for “Elderly” combined with “Periodontitis”, “Tooth extraction”, “Dentures”, and “Caries”. Similarly, statistically significant differences were noticed in worldwide search volumes for “Elderly” combined with “Consult”, “Screening”, and “Assistance”, when comparing searches for teledentistry applications among the elderly in the 36 months before and after the COVID-19 outbreak.

Overall, the pandemic has led to an increase in interest in elderly oral and dental needs and related interventions, including teledentistry applications, and specifically, the provision of oral and dental consult, screening, and assistance, which are more easily practicable remotely [1].

The main limitation of the study is based on the daily changes of information search data in the Google search engine; therefore, the present results should be constantly updated. In addition, Google Trends shows relative search volumes from 1 to 100, so it does not indicate the absolute number of searches. Furthermore, Google is not the only search engine available on the Internet, although it is the only one that records search data and makes it publicly available.

Nonetheless, the present cross-sectional analysis was the first to assess the level of interest in Google searches for oral and dental needs and teledentistry applications among the elderly, comparing search volume in the 36 months before and after the COVID-19 pandemic outbreak.

Future studies should include other websites, such as Bing, Baidu, or Yahoo, which may be more popular in some countries, and further research should predict demand and access to remote dental care based on Internet users’ search queries.

## 5. Conclusions

Based on Google Trends relative search volumes from January 2004 to December 2022, interest in Google searches for “Elderly” was diffusely medium–high, while searches for “Teledentistry” indicated a low interest in the topic. Specifically, the oral and dental needs of the elderly were less searched on Google than teledentistry applications. However, a positive correlation was found between searches for “Elderly” and “Teledentistry”, and searches for potential teledentistry applications were also all strongly correlated with searches for “Elderly”. This finding suggests that interest in teledentistry and its applications is strongly related to interest in the older population, which is consistent with the assumption that older adults represent the population segment that could benefit most from these tools. A positive correlation was also found between searches for “Elderly” and searches for almost all oral and dental needs typical of the geriatric population, likely demonstrating that interest in oral and dental problems is partially related to interest in the needs of the elderly. Global Google searches related to teledentistry, the elderly, oral and dental needs, and nearly all teledentistry applications generally increased in the 36 months after the COVID-19 pandemic outbreak.

Considering that Google users’ interest indirectly provides insights into attitudes toward teledentistry indications and applications, the present analysis suggests that more information about teledentistry should be disseminated to increase knowledge and awareness of the potential benefits for oral and dental care, especially among the elderly.

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