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Effect of COVID-19 on orthodontic treatment/practice- A systematic review and meta-analysis

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Abstract

Coronavirus disease of 2019 (COVID-19), which has affected almost all medical professions, has had a significant negative influence on dental care. Additionally, non-urgent dental procedures were stopped during the epidemic in a number of countries. The purpose of this systematic review was to examine the impact of COVID-19 on individuals who had undergone or are currently having orthodontic treatment in any capacity during/after the pandemic's occurrence. After a thorough search of the online journals, a total of 634 documents were found, and 416 of the papers were initially chosen. The removal of 362 similar or duplicate publications that followed led to the initial availability of 54 separate papers. The final selection consisted of 23 documents, mostly *in vitro* investigations, cross-sectional studies, and comparative evaluations, which satisfied the necessary inclusion and exclusion criteria. COVID-19 had a significant impact on nearly every sphere of the patients' lives who were undergoing orthodontic treatment. However, people who are currently availing of various orthodontic treatment modalities did not experience the same issues as the ones faced by patients earlier. Teleorthodontics emerged as a viable option to access treatment during the lockdown period caused due to the pandemic. COVID-19 also had an overall negative impact on the psyche and morale of orthodontists around the world.

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Keywords:

Anxiety, COVID-19, orthodontic appliances, orthodontic treatment, orthodontics, teleorthodontics

Introduction

Dental care has been severely impacted by the Coronavirus disease of 2019 (COVID-19), which has affected nearly all medical specialties.^[1] It should be noted that non-urgent dental operations were suspended in several nations during this time.^[2] Global socioeconomic effects from COVID-19 have resulted in a drop in average monthly income for all persons.^[3] Dentistry is thought to have a high infection risk because of direct contact with patient fluids during appointments and potential cross-infection. Transmission mechanisms have affected a number of professions.^[4,5]

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Numerous studies have documented large rises in people's levels of anxiety and despair as a result of rising health worries, unemployment, and decreased social interaction brought on by isolation and lockdown during the early stages of COVID-19.^[3,6-8] According to studies done on orthodontic patients during the first wave of the pandemic, the patients were extremely anxious about attending their appointments, worried about the length and delay of their treatment, and even worried that there might be a rise in the failure rate of their orthodontic appliances and a decline in their periodontal health.^[9,10] More than one-third of orthodontic patients in the early stages of the pandemic reported experiencing

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mental distress, and Xiong *et al.*^[11] found that the type of appliance, length of time since the previous dental appointment, and method of communication with the orthodontist all had an impact on how severe this distress was.

According to data from previous pandemics, psychological discomfort may continue long after the pandemic is gone in addition to having acute consequences on mental health.^[12] The psychological effects of COVID-19 quarantine may also be extensive, powerful, and long-lasting; this has been hypothesized. According to a longitudinal study by Veldhuis *et al.*,^[13] although the prevalence of depressive symptoms and suicidal thoughts and behaviors increased between April 28 and September, the prevalence of acute stress symptoms decreased. This study evaluated the effects of the COVID-19 pandemic on mental health in 2020. In a different longitudinal study, Pieh *et al.*^[14] assessed participants' mental health before the COVID-19 lockdown and six months later. They found that while stress levels significantly dropped and well-being levels significantly rose, the percentage of participants with mental health issues did not change.

Since the field of dentistry is considered to have a high infection risk due to appointment-related direct contact with patient fluids and possible cross-infection, this systematic review and meta-analysis aimed to analyze the impact of COVID-19 on patients who had undergone or are currently having orthodontic treatment in any capacity following the occurrence of the pandemic. This study's secondary goal was to evaluate how the pandemic affected orthodontists as well.

Materials and Methods

Protocol employed

This systematic review was performed as per the Preferred Reporting Items for Systematic Review and Meta-analysis (PRISMA) strategy and rules from the Cochrane group and the book *Orderly reviews in Health Care: Meta Examination*.^[15]

Review hypotheses

This systematic review and meta-analysis was aimed at analyzing the effects of COVID-19 on the patients who underwent/are currently undergoing orthodontic treatment in any form after the incidence of the pandemic. Also, a secondary objective of this study was to assess the effect of the pandemic on orthodontists as well.

Study selection

There were a total of 634 documents discovered after an extensive search of the online journals, and 416 of the papers were selected initially. Following that,

362 similar/duplicate articles were eliminated, which resultantly made 54 separate papers available at first. The abstracts and titles of submissions were then reviewed, and a further 31 papers were eliminated. Finally, 23 documents [Figure 1] that met the requisite inclusion and exclusion criteria were chosen, which primarily included *in vitro* studies, literature reviews, and comparative assessments.

Inclusion criterion

Articles that contained relevant data for our review objectives were selected for full-text screening. Studies that reported clinical trials, *in vitro* studies, randomized/non-randomized studies, systematic/literature reviews containing substantial sample volume, and detailed case reports were considered for inclusion in our review. We also monitored studies that possessed a higher methodological quality.

Exclusion criteria

The following were excluded from the scope of our systematic review: incomplete data, seminar presentations, scholarly articles, grey literature, placebo-controlled studies, and opinion articles.

Since the literature available on this topic was quite scant in volume, we did not limit our search in terms of the time period when the studies were published, that is we took into account all the papers that were published with context to our topic (where the number of papers itself was found to be quite sparse in number). Also excluded were literature reviews and cases published in languages other than English.

Search strategy

Using relevant keywords, reference searches, and citation searches, the databases PubMed-MEDLINE, Web of Science, Cochrane, and Scopus were all searched. "Anxiety," "COVID-19," "Orthodontics," "Orthodontic appliances," and "Orthodontic treatment" were the search terms used to access the database.

Data selection and coding

Two independent reviewers located the relevant papers by using the right keywords in various databases and online search tools. The chosen articles were compared, and a third reviewer was brought in if there was a dispute.

After choosing the articles, the same two reviewers independently extracted the following data: author, year of publication, country, kind of publication, study topic, population demographics (n, age), outcome measure(s), relevant result(s), and conclusion(s). The data were compared and any differences were discussed with the third reviewer.

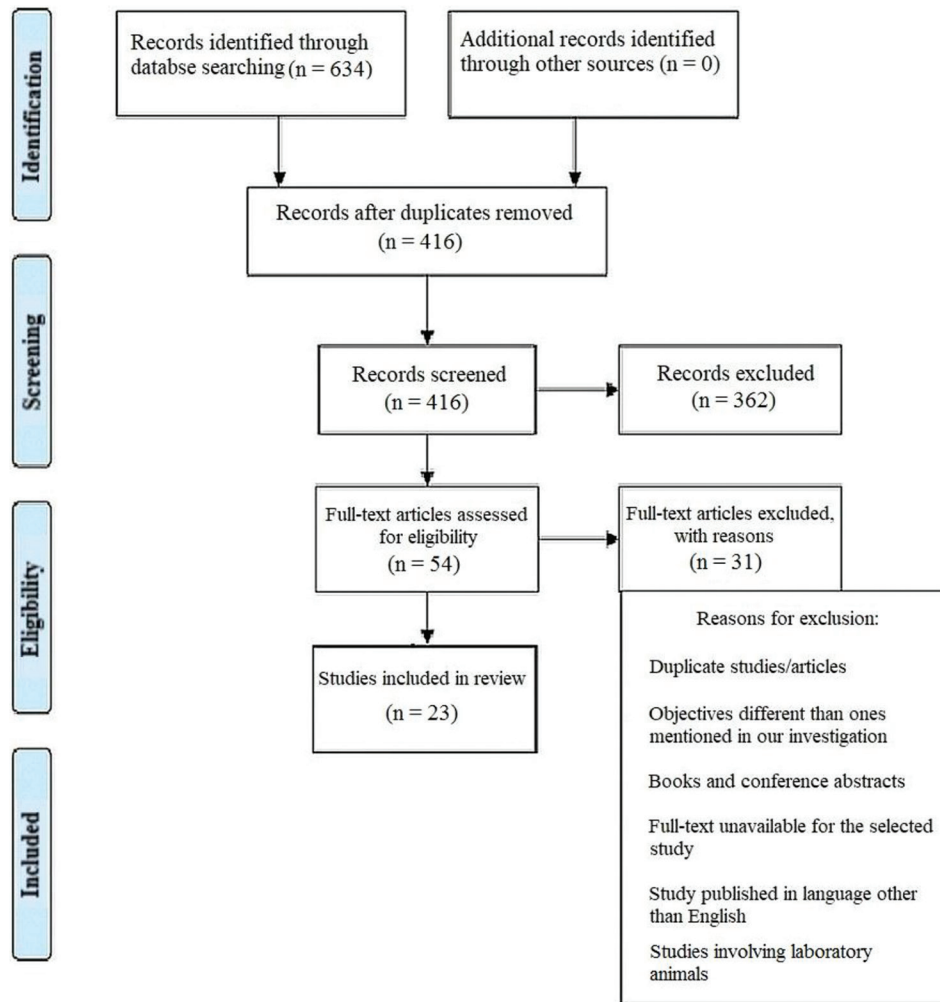


Figure 1: Representation of a selection of articles through PRISMA framework

Statistical analysis

After selecting data on the sample size, variables analyzed, and various elements of the investigations, the data were then entered into the Revman 5 programme for meta-analysis. Forest plots illustrating the odds ratio for different study methodologies were obtained as part of the meta-analysis for our study, as shown in Figures 2-4.

Risk of bias assessment

The AMSTAR-2 technique^[16] was used to evaluate the risk of bias in the studies we chose. AMSTAR 2 joins a number of other instruments that have been released for this purpose as a critical evaluation tool for systematic reviews. As seen in Table 1 below, it is a 16-point checklist. Two instruments that have drawn a lot of attention served as the foundation for the creation of the original AMSTAR tool. The original AMSTAR was duplicated into two newly produced instruments. The AMSTAR 2 risk of bias items identify the domains specified in the Cochrane risk of bias instruments for systematic reviews. In each case, these indicate an

agreement that was achieved after input from more than 30 methodology experts [Table 2].

Results

Table 2 lists the study's design, methods, description, and results. Figures 2-4 show the findings of the meta-analysis.

Discussion

Most dental offices were shut down during the various lockdowns due to the increased danger of infection, which created a challenging scenario for patients undergoing orthodontic treatment because they normally need frequent visits to their orthodontist over a lengthy period of time.^[19]

Because orthodontic treatment is elective and lasts a long time, thousands of patients in lockdown areas missed their monthly appointments. Both patients and orthodontists expressed tremendous anxiety

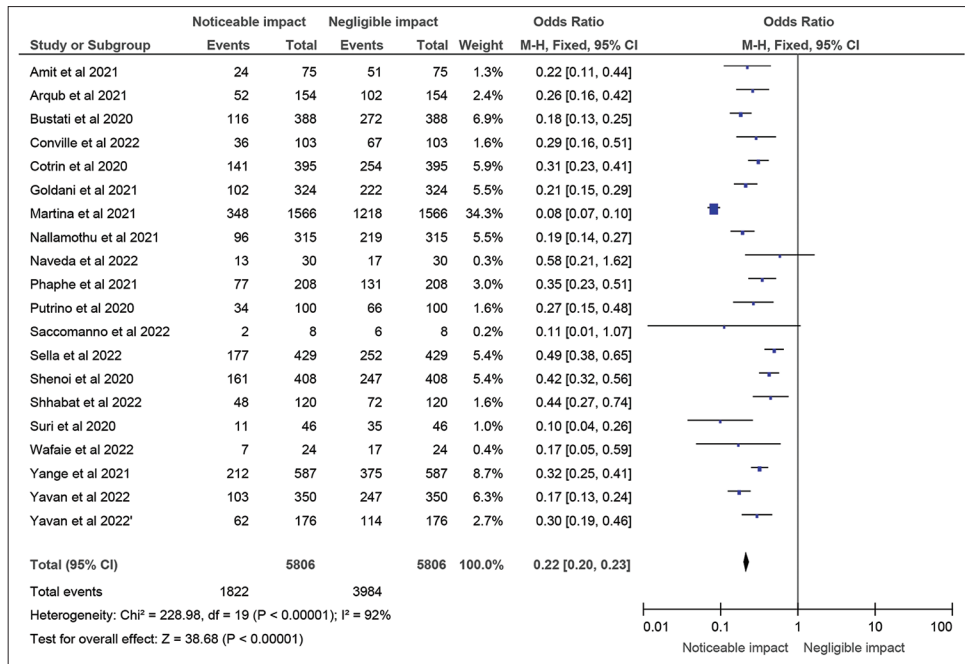


Figure 2: Odds ratio of studies selected in this systematic review that assessed the impact of COVID-19 on orthodontic treatment modalities represented on a forest plot after meta-analysis

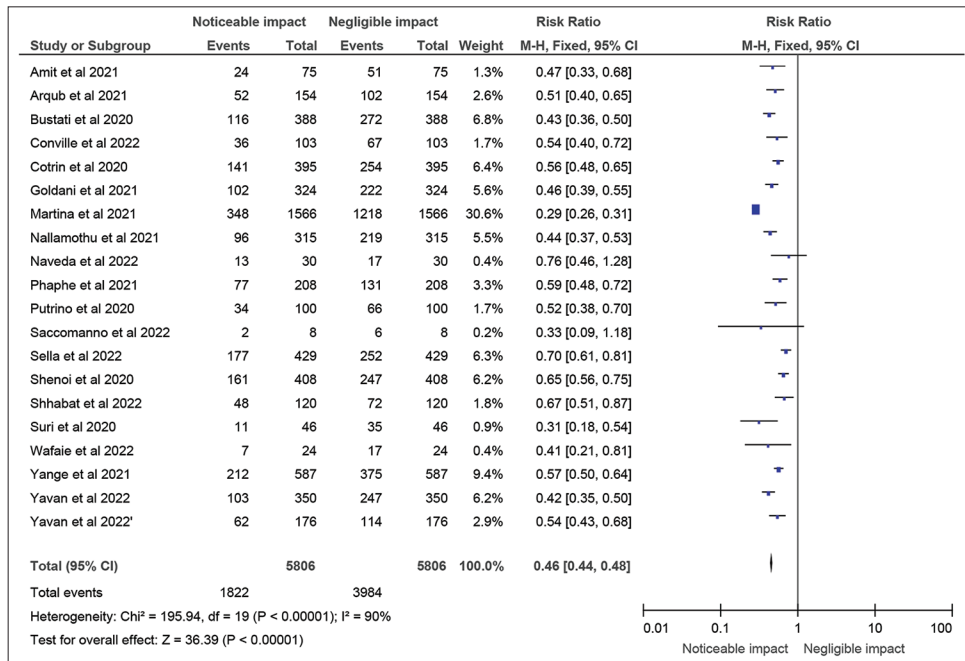


Figure 3: Risk ratio of studies selected in this systematic review that assessed the impact of COVID-19 on orthodontic treatment modalities represented on a forest plot after meta-analysis

and perplexity regarding the unexpected cessation of treatment as well as any potential issues that orthodontic appliance components may have produced during this extended interval. Despite the fact that orthodontic treatment involves aesthetic and elective components, emergency situations might nonetheless arise.^[19]

Clinicians and patients both welcomed the use of teleorthodontics in the pandemic's emergency

management, and the publications analyzed in this study highlighted a number of advantages. The ability to triage remotely to determine whether a patient needs an office visit or if there is a chance to resolve the issue through the media,^[17,18] the ability to cut down on the amount of time the patient spends in the chair,^[26] and the ability to send and evaluate images and radiographs quickly^[10,19] are a few of these benefits. The ability to reassure patients who experience anxiety, fear, or a sense of abandonment

Table 1: AMSTAR-2 16-point checklist of risk of bias assessment in studies selected for the systematic review

Studies selected	Question and inclusion	Protocol	Study design	Comprehensive search	Study selection	Data extraction	Excluded studies justification	Included study details
Kumar <i>et al.</i> 2021 ^[17]	Yes	Yes	Yes	Yes	Yes	No	No	No
Arqub <i>et al.</i> 2021 ^[18]	Yes	Yes	Yes	Yes	Yes	No	No	No
Bustati <i>et al.</i> 2020 ^[19]	Yes	Yes	Yes	Yes	Yes	No	No	No
Caprioglio <i>et al.</i> 2020 ^[20]	Yes	Yes	Yes	Yes	Yes	No	No	No
Conville <i>et al.</i> 2022 ^[9]	Yes	Yes	Yes	Yes	Yes	No	No	No
Cotrin <i>et al.</i> 2020 ^[10]	Yes	Yes	Yes	Yes	Yes	No	No	No
Moghadam <i>et al.</i> 2021 ^[21]	Yes	Yes	Yes	Yes	Yes	No	No	No
Martina <i>et al.</i> 2021 ^[22]	Yes	Yes	Yes	Yes	Yes	No	No	No
Nallamotheu <i>et al.</i> 2021 ^[23]	Yes	Yes	Yes	Yes	Yes	No	No	No
Naveda <i>et al.</i> 2022 ^[24]	Yes	Yes	Yes	Yes	Yes	No	No	No
Phaphe <i>et al.</i> 2021 ^[25]	Yes	Yes	Yes	Yes	Yes	No	No	No
Putrino <i>et al.</i> 2020 ^[26]	Yes	Yes	Yes	Yes	Yes	No	No	No
Saccomanno <i>et al.</i> 2022 ^[27]	Yes	Yes	Yes	Yes	Yes	No	No	No
Sella Tunis <i>et al.</i> 2022 ^[28]	Yes	Yes	Yes	Yes	Yes	No	No	No
Shenoi <i>et al.</i> 2020 ^[29]	Yes	Yes	Yes	Yes	Yes	No	No	No
Shhabat <i>et al.</i> 2022 ^[30]	Yes	Yes	Yes	Yes	Yes	No	No	No
Suri <i>et al.</i> 2020 ^[31]	Yes	Yes	Yes	Yes	Yes	No	No	No
Sycinska-Dziarnowska <i>et al.</i> 2021 ^[32]	Yes	Yes	Yes	Yes	Yes	No	No	No
Wafaie <i>et al.</i> 2022 ^[33]	Yes	Yes	Yes	Yes	Yes	No	No	No
Wu <i>et al.</i> 2021 ^[34]	Yes	Yes	Yes	Yes	Yes	No	No	No
Yavan <i>et al.</i> 2021 ^[35]	Yes	Yes	Yes	Yes	Yes	No	No	No
Yavan <i>et al.</i> 2022 ^[36]	Yes	Yes	Yes	Yes	Yes	No	No	No
Yavan <i>et al.</i> 2022 ^[37]	Yes	Yes	Yes	Yes	Yes	No	No	No
Studies selected	Risk of bias	Funding sources	Statistical methods	Risk of bias in meta-analysis	Risk of bias in individual studies	Explanation of heterogeneity	Publication bias	Conflict of interest
Amit <i>et al.</i> 2021 ^[17]	Yes	N/A	Yes	Yes	Yes	Yes	Yes	Yes
Arqub <i>et al.</i> 2021 ^[18]	Yes	N/A	Yes	Yes	Yes	Yes	Yes	Yes
Bustati <i>et al.</i> 2020 ^[19]	Yes	N/A	Yes	N/A	Yes	Yes	Yes	Yes
Caprioglio <i>et al.</i> 2020 ^[20]	Yes	N/A	Yes	Yes	Yes	Yes	Yes	Yes
Conville <i>et al.</i> 2022 ^[9]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cotrin <i>et al.</i> 2020 ^[10]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Moghadam <i>et al.</i> 2021 ^[21]	Yes	N/A	Yes	Yes	Yes	Yes	Yes	Yes
Martina <i>et al.</i> 2021 ^[22]	Yes	N/A	Yes	Yes	Yes	Yes	Yes	Yes
Nallamotheu <i>et al.</i> 2021 ^[23]	Yes	N/A	Yes	N/A	Yes	Yes	Yes	Yes
Naveda <i>et al.</i> 2022 ^[24]	Yes	N/A	Yes		Yes	Yes	Yes	Yes
Phaphe <i>et al.</i> 2021 ^[25]	Yes	N/A	Yes		Yes	Yes	Yes	Yes
Putrino <i>et al.</i> 2020 ^[26]	Yes	N/A	Yes	Yes	Yes	Yes	Yes	Yes
Saccomanno <i>et al.</i> 2022 ^[27]	Yes	N/A	Yes	Yes	Yes	Yes	Yes	Yes
Sella Tunis <i>et al.</i> 2022 ^[28]	Yes		Yes	Yes	Yes	Yes	Yes	Yes
Shenoi <i>et al.</i> 2020 ^[29]	Yes	N/A	Yes	Yes	Yes	Yes	Yes	Yes
Shhabat <i>et al.</i> 2022 ^[30]	Yes	N/A	Yes	Yes	Yes	Yes	Yes	Yes
Suri <i>et al.</i> 2020 ^[31]	Yes	N/A	Yes		Yes	Yes	Yes	Yes
Sycinska-Dziarnowska <i>et al.</i> 2021 ^[32]	Yes	N/A	Yes	Yes	Yes	Yes	Yes	Yes
Wafaie <i>et al.</i> 2022 ^[33]	Yes	N/A	Yes	Yes	Yes	Yes	Yes	Yes
Wu <i>et al.</i> 2021 ^[34]	Yes		Yes	Yes	Yes	Yes	Yes	Yes
Yavan <i>et al.</i> 2021 ^[35]	Yes	N/A	Yes		Yes	Yes	Yes	Yes
Yavan <i>et al.</i> 2022 ^[36]	Yes	N/A	Yes	Yes	Yes	Yes	Yes	Yes
Yavan <i>et al.</i> 2022 ^[37]	Yes	N/A	Yes	Yes	Yes	Yes	Yes	Yes

during therapy,^[19,26,27] as well as the potential for periodically checking on patients' oral health status and encouraging them to practice good oral hygiene,^[26,27] are additional positive aspects that should be highlighted.

On the other side, the drawbacks of teleorthodontics were also looked into. Even though it doesn't appear to be appropriate in every circumstance or for extended periods of time, Saccomanno *et al.*^[27] in their study from

Table 2: Description and outcomes as observed in the studies selected for the systematic review

Author and year of study	Sample size	Mean age; male: female ratio	Study design	Study objective/description	Study inference/outcome
Kumar <i>et al.</i> 2021 ^[17]	75	NA; 50:15	Questionnaire based study	The current study's objective was to assess how the COVID-19 epidemic had affected the orthodontic industry in India. The current study, which was done via a questionnaire, included 75 orthodontists. The inquiries focused on the impact of the COVID-19 epidemic on Indian orthodontists and orthodontic practice before and after it.	The number of patients was seen to have drastically decreased (by 92%) from the pre-COVID-19 era, and the data were also statistically significant. Orthodontists also experienced a decline (76%) in the number of old patients who were recalled for follow-up in order to continue their treatment.
Arqub <i>et al.</i> 2021 ^[18]	154 patients	29.3 years; 38:62	Questionnaire based cross-sectional study	In addition to assessing patients' levels of mental distress and its relationship to their confidence in resuming care, the authors sought to provide a comprehensive picture of patients' perspectives, worries, and expectations regarding their treatment throughout the clinic lockdown during the pandemic. Adult orthodontic patients were given a paper questionnaire after a lockdown at a university that was confidential and validated in person. With regard to orthodontic treatment during the pandemic, the survey concentrated on the clinical aspects and patient opinions. They were evaluated psychologically using the Kessler Mental Distress Scale (K10).	Emergency situations during the closure (21%, 32/154) were mostly aggravated by protruding wires. Patients preferred their present fixed appliances to transparent aligners and had an unfavorable opinion of tele-dentistry. When therapy was resumed, 80.51% of patients expressed extreme satisfaction with the stringent procedures and high levels of confidence in doing so. Average anxiety levels were low, and there was a slight correlation between mental distress and less confidence in starting therapy.
Bustati <i>et al.</i> 2020 ^[19]	388 subjects	20.4 years; 25:75	Questionnaire based cross-sectional study	This study aimed to evaluate the difficulties experienced by orthodontic patients and their preferred methods for resolving these difficulties during this epidemic. Patients having orthodontic treatment at a public or private facility were provided an online survey.	Of all participants, 27.3% (106) were still unable to make it to their visits, and 69% (244) said that the clinic shutdown was the primary cause. The patients dealt with a variety of issues depending on the sort of device they were using. Only 21% (64) of the 84% (327) fixed appliance participants said they had no trouble, compared to 39% (11) and 36% (8) for the clear aligner and removable appliance groups, respectively.
Caprioglio <i>et al.</i> 2020 ^[20]	-	-	Literature review	A concise overview of recommendations for managing orthodontic patients during a COVID-19 emergency was put out in this literature study, with a focus on virtual help tools and emergency classification.	According to the authors, the orthodontist should not have permitted the patient to utilize any equipment that could have caused a rush-hour situation in the office, such as elastics, face masks, headgear, lip bumpers, or other non-removable appliances that the patient could have activated. At that time, it was crucial to handle in the office with the required PPE only the genuine emergencies that the patient could not have handled remotely, while also adhering to the rules established by the WHO and local authorities.

Contd...

Table 2: Contd...

Author and year of study	Sample size	Mean age; male: female ratio	Study design	Study objective/description	Study inference/outcome
Conville <i>et al.</i> 2022 ^[9]	103 patients	-	Questionnaire based study	The following items were evaluated using a 12-item survey created on the SurveyMonkey platform: the patients' attitudes toward going to their orthodontic appointments; their desire to continue with their treatment; the number of patients who experienced appliance problems during the lockdown; how patients sought assistance during the first national lockdown period; and any other worries about the impact on their orthodontic treatment. This was done to assess how the coronavirus pandemic affected patients who were undergoing orthodontic treatment.	Of the 103 participants, 45% needed a face-to-face appointment to fix a problem with their orthodontic appliance; 45% of patients were able to fix the problem digitally by getting advice over the phone or email from their provider or by accessing online resources; and 99% of patients wanted to continue with their orthodontic treatment.
Cotrin <i>et al.</i> 2020 ^[10]	395 orthodontists	20-41+years; 33.7:66.3	Questionnaire based study	The objective of the current study was to identify the most prevalent orthodontic emergencies and urgencies during the coronavirus disease 2019 (COVID-19) pandemic and to evaluate how Brazilian orthodontists were managing their patients and difficulties. Brazilian orthodontists were requested to take part in an anonymous online survey. 395 orthodontists (specialists, MScs, and PhDs) responded over the course of 48 hours (May 1-3, 2020). They supplied information on the sort of emergency care offered, the type of appliance and urgencies, the dentist office and appointments throughout the pandemic, and other topics. It was also determined how worried people were about how the pandemic will affect patients' orthodontic treatments and the dentist's bottom line.	The vast majority of responses were specialists. The majority of orthodontists exclusively dealt with urgent cases or emergencies. Bracket breakage, archwire breakage, and molar tube and/or band fracture were the most common emergencies. The most typical style of fixed stainless steel equipment used in connection with unplanned appointments. The majority of clients used the expert WhatsApp messenger to communicate with the orthodontist (WhatsApp Inc, Menlo Park, Calif). The financial effects of the pandemic were more of a worry to orthodontists than the orthodontic procedure itself.
Moghadam <i>et al.</i> 2021 ^[21]	324 patients	32.43 years; 75:249	Questionnaire based study	The purpose of this study was to assess how the COVID-19 pandemic affected orthodontic appointments as well as the worries and anxiety levels of patients in Iran. Patients at private orthodontic offices in Birjand and Mashhad, the capitals of Iran's Eastern Provinces, were sent an anonymous 40-question survey online. The questionnaire was also given to Mashhad Dental School's orthodontic patients.	Participants said that they only left the house to fulfill daily needs in 57% of cases. 72 percent of the participants said they were at ease with the COVID-19 epidemic and its effects. Most patients (74%) stated they would attend their orthodontic appointment very away, and 41% said their biggest worry was the possibility of a delay in the finish of their treatment. Patients with sufficient OHL made up 45% of the population. The frequency of daily tooth cleaning, concerns about the pandemic's effects on orthodontic treatment, and willingness to attend orthodontic treatment all significantly correlated with OHL.

Contd...

Table 2: Contd...

Author and year of study	Sample size	Mean age; male: female ratio	Study design	Study objective/description	Study inference/outcome
Martina <i>et al.</i> 2021 ^[22]	1566 patients	18-70+; 698:852	Questionnaire based study	The current study sought to determine how patients felt about the dental office during the COVID-19 epidemic and whether the pandemic would affect orthodontic patients' attendance at the dental office. Italian dental patients were given an online survey that included the Patient Health Questionnaire-4 (PHQ-4) and questions about their perceptions of the risks associated with visiting the dentist, their worries about finishing their orthodontic treatment, and the onset of temporomandibular disorders (TMD).	The survey was completed by 1566 people in total, 486 of whom were undergoing orthodontic treatment or had children who were. A total of 866 participants (55.3%) believed there was a higher chance of getting the COVID-19 infection in a dental office; this belief was more common in women than men, people over 60, and those who reported feeling very distressed. However, 894 patients (57.1%) felt at ease visiting the dentist again. The majority of orthodontic patients (84%) said they would continue their care. There was a modest increase in the frequency of TMD discomfort following the lockdown (356 versus 334).
Nallamotheu <i>et al.</i> 2021 ^[23]	315 orthodontists	<30-70 years; 65:35	Questionnaire based study	The study's objective was to evaluate the treatment and psychological effects of the COVID-19-related lockdown on orthodontists and orthodontic postgraduate students. 315 orthodontic specialists and postgraduate residents from various Middle Eastern nations participated in the survey. Through an online data collecting tool (Google forms), a pretested self-administered questionnaire including participant sociodemographics and participant perceptions of the COVID-19 pandemic impact was sent to the consenting participants.	The majority of participants (87.61%) claimed that the pandemic would permanently alter the way they practiced orthodontics and that it would also result in a future decline in the number of orthodontic patients (78.73%). However, a sizable portion of orthodontists (67.61%) believed that the pandemic would not have an impact on the continued viability of their line of work. The majority of respondents (88.57%) discussed the negative financial effects of COVID-19 on their income, and regarding the impact of COVID-19 on psychosocial well-being, 73.01% had experienced anxiety and depression. In addition, 88.25% were enthusiastic about the profession's future, and 68.57% enjoyed life with their family due to lockdown. When asked about their social life with family and friends, the majority of participants (66.34%) had the opinion that they enjoyed it.
Naveda <i>et al.</i> 2022 ^[24]	30 patients	8-21 years	Questionnaire based study	The purpose of this study was to assess orthodontic patients' self-reported requirements and experiences during the quarantine period without in-person sessions. A random sample of thirty patients undergoing orthodontic treatment was chosen. During the second month of the COVID-19 quarantine in Brazil, a phone survey was administered that included questions about the psychological and physical effects of the quarantine.	16 percent of the patients reported experiencing pain as a result of their orthodontic device. 23.33% of appliances were found to have been broken. Twenty percent felt they needed to see an orthodontist right away, and 3.33 percent went to a private practice. Furthermore, 23% of respondents said they would rather use WhatsApp to contact the orthodontist than look for an appointment, even in an emergency. While 66.7 percent of patients reported that their oral hygiene was getting better, 36.6 percent of patients said it was getting worse, and 56.6 percent said it was staying the same. 60 percent of respondents expressed concern about the orthodontic treatment.

Contd...

Table 2: Contd...

Author and year of study	Sample size	Mean age; male: female ratio	Study design	Study objective/description	Study inference/outcome
Phaphe <i>et al.</i> 2021 ^[26]	208 subjects	16-25+years; 90:118	Questionnaire based study	This study's objective was to evaluate how COVID-19 lockdown affected individuals who were receiving active orthodontic treatment and how they felt about it. Using communication tools like WhatsApp, messaging apps, and email, a self-created 10-question survey was extensively distributed among orthodontic patients. The final sample for the study was made up of just 208 participants who submitted the questionnaire. Identification information was not gathered from the study individuals, and participation in the study was completely voluntary.	According to the study, the majority of female patients were nervous, concerned, and anxious because of their longer treatment times, discomfort during the lockout, financial concerns, and treatment outcomes as a result of missing follow-up appointments during the lockdown. The general perspective for the future following the shutdown revealed worry among orthodontic patients.
Putrino <i>et al.</i> 2020 ^[26]	100 patients	7-46 years; 43:57	Observational study	The major goal of this study was to evaluate the viability of managing patients remotely in accordance with teleorthodontic principles in order to comprehend its potential utility in future routine activities and the prospective effects of the pandemic on various orthodontic treatments. During quarantine, 100 orthodontic patients were examined using video calls and pictures that the patients had submitted after following the correct guidelines. Based on the type of therapy, three categories had been identified: Appliances that are A-fixed, B-removable, and C-clear aligners. Events pertinent to oral and gingival health, appliance integrity, symptoms associated with orthodontic therapy, and overall treatment progress were noted.	Higher percentages of dental plaque (16 and 13%), deciduous tooth loss (8 and 16%), and gingival irritation (27 and 22%) were recorded in the A and B groups. In groups A and C (22 and 23%), bracket and attachment separation were the most prevalent occurrences. Both the A and B groups (35 and 32%) reported experiencing pain and discomfort. The C (51% improved dental alignment) and B (31% improved malocclusions) groups continued to benefit more from the treatments.
Saccomanno <i>et al.</i> 2022 ^[27]	8 studies	-	Systematic review	The purpose of this systematic evaluation of the literature was to assess the most prevalent orthodontic emergencies that occurred during the COVID-19 pandemic and how it was handled by teleorthodontics.	The articles demonstrated that voice conversations and smartphone apps like WhatsApp® Messenger were the most popular ways for patients to get in touch with their orthodontists. Patients shared their orthodontic emergency through these platforms. The majority of these were fixed multibracket appliances, and the most frequent problems were ache and discomfort, appliance loss or fracture, protruding distal ends of archwires, brackets, tubes, and bands, or retainer separation.

Contd...

Table 2: Contd...

Author and year of study	Sample size	Mean age; male: female ratio	Study design	Study objective/description	Study inference/outcome
Sella Tunis <i>et al.</i> 2022 ^[28]	429 patients	19.23 years; 172:257	Questionnaire based study	The purpose of the current study was to describe the activities in orthodontic offices during the COVID-19-induced lockdown and the inter-lockdown periods as well as to assess patients' perceptions of their anxieties, their level of treatment participation, and their emergency needs during the lockdown. From 1 January 2020 to 8 March 2021, 11 private orthodontic offices—during which there were three lockdowns and inter-lockdowns—collected data. Information was acquired on the quantity of admissions, missed appointments, and emergency visits.	Compared to the pre-pandemic period, there was a sizable increase in the number of scheduled appointments during the inter-lockdown periods. There was no difference between the various periods in the number of missed/ canceled or urgent appointments. Appliance problems accounted for 89.6% of the emergency visits, and 68.7% of the subjects were instructed to visit clinics. There was no noticeable increase in the number of missed and urgent appointments during the COVID-19 pandemic's peak waves.
Shenoi <i>et al.</i> 2020 ^[29]	408 individuals	-	Questionnaire based study	The purpose of this study was to evaluate how the COVID-19-related lockdown affected orthodontic patients' treatment and psychological well-being. A self-designed online exploratory questionnaire with 15 questions was given to 500 potential respondents for this purpose, who were chosen from lists that were acquired through messages and emails. All responses were required, and the survey was anonymous and did not include any identifying information. Before deciding to take part in the study, online consent was obtained.	According to the survey, the majority of patients were impacted by their inability to receive orthodontic care. The same was attributed to, among other things, a lack of communication between orthodontists and patients, anxiety of lengthening treatment times, discomfort from sticking wires and broken brackets, etc., Patients were also aware of the value of orthodontic appointments.
Shhabat <i>et al.</i> 2022 ^[30]	120 subjects	18.5 years; 1:2	Questionnaire based cross-sectional study	The goal of this study was to evaluate the difficulties that patients receiving orthodontic treatment faced during the pandemic and their attitude toward overcoming such difficulties. At Prince Rashid Hospital in the north of Jordan, a cross-sectional sample of orthodontic patients was enlisted to take part in a self-administered questionnaire that asked about orthodontic issues that came up during the lockdown, solutions for these issues, and worries about their treatment.	The majority of participants (n=86) had fixed orthodontic appliances, and 82% of them reported having various orthodontic issues, but exposed wire ends and loose brackets were the most frequently reported issues. A broken or loose appliance was the most frequently reported issue (n=1434) among those who had removable appliances. However, users of both kinds of appliances chose to put off fixing the issue until dental offices reopened. Additionally, most patients missed at least one appointment for a variety of reasons, and nearly two-thirds (76.6%) of them failed to contact their orthodontists during the lockdown. Because they were worried about having to wait a long time for another appointment, patients expressed their displeasure with the decision to close dental offices during the pandemic.

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Table 2: Contd...

Author and year of study	Sample size	Mean age; male: female ratio	Study design	Study objective/description	Study inference/outcome
Suri <i>et al.</i> 2020 ^[31]	46 studies	-	Systematic review	This study's objective was to provide a thorough overview of the effects of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection and the coronavirus disease 2019 (COVID-19) on orthodontic treatment, emergency orthodontic care, and contingency management, using the most recent data and literature.	Elective orthodontic treatment was halted during the COVID-19 pandemic and only resumed when approved by federal, provincial, and local health regulatory agencies. An emergency approach based on efficient triage and communication was used to deliver emergency orthodontic treatment. When and where it was feasible, treatment recommendations were first given remotely.
Sycinska-Dziarnowska <i>et al.</i> 2021 ^[32]	-	-	Scientometric analysis	Using Google Trends, the data regarding orthodontic queries was examined in real-time. In relation to the year before the pandemic outbreak and the period of the pandemic, search terms such as "braces," "invisiblealign," "get braces," "get braces off," "braces discomfort," and the phrase "social distancing" were examined. As another example of various orthodontic appliances, the five-year trend for queries "braces" vs. "invisiblealign" was contrasted.	Due to the widespread announcements of restrictions and lockdowns in the spring of 2020, there was a significant drop in orthodontics phrase searches. During the initial lockdown in 2020, there was less interest in the question "braces pain." While the number of searches for "braces" remained largely stable over the investigated time period, the number of searches for "invisiblealign" increased steadily over time.
Wafaie <i>et al.</i> 2022 ^[33]	24 patients	25.2 years; 7:17	Interview based study	In order to give orthodontic therapy in the best possible way, it was intended to gather information from patients on their general practices and dental health during this period, a semi structured face-to-face interview design. In order to gather qualitative information from 24 orthodontic patients who were isolated during the COVID-19 epidemic, a purposive sample technique was used. All interviews were digitally recorded, and then they were all verbatim transcribed.	The results of the study revealed that COVID-19 affected the provision of oral healthcare to orthodontic patients while they were under quarantine. Patients who experienced treatment interruption and pandemic lockdown described behavioral and psychosocial changes as a result.
Wu <i>et al.</i> 2021 ^[34]	587 subjects	24.68 years; 22.7:77.3	Questionnaire based study	This cross-sectional study was conducted in response to the COVID-19 epidemic in China to evaluate the psychological well-being of patients with temporomandibular disorders (TMD), orthodontic patients, and the general populace. Chinese researchers created an anonymous online survey that asked respondents about their backgrounds, how they saw the pandemic, and their levels of anxiety and despair using the Kessler Psychological Distress Scale (K10). The respondents were split into three groups: ORTHO, TMD, and Control.	This study demonstrated that, overall, there was not much hope for the COVID-19 pandemic's mental health. Compared to orthodontic patients and the general population, TMD patients reported higher levels of anxiety and sadness.

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Table 2: Contd...

Author and year of study	Sample size	Mean age; male: female ratio	Study design	Study objective/description	Study inference/outcome
Yavan <i>et al.</i> 2021 ^[35]	-	-	Retrospective study	Patients who sought treatment at a tertiary orthodontic referral center between January 1, 2016, and December 31, 2020 were included on the retrospective analysis. Clinical and demographic data were compared between the pre-pandemic (2017-2020) and post-pandemic (2020) periods, including age, age category (child, young adult, adult), gender, and numbers of monthly and annual new-patient visits. The daily average appointment numbers for 2019 and 2020 were compared.	In the pre-pandemic period, there were 240.69 new patient visits per month on average, compared to 113.75 new patient visits per month in the year 2020. While the average daily new-patient visits in 2020 decreased significantly in all months, save for January, compared to the monthly numbers from the previous year, the average number of monthly new-patient visits decreased by 48.3% in comparison to 2019. Regarding gender, there was no discernible difference between the pre-pandemic era and 2020.
Yavan <i>et al.</i> 2022 ^[36]	350 patients	16.85 years; 101:249	Observational study	The goal of this experiment was to gather data on the frequency of fixed orthodontic appliance failures and the state of the patients' periodontal health both during and following the lockout period. 350 orthodontic patients in Adyaman, Turkey, who had undergone orthodontic and periodontal tests following the lockout period, made up the sample. Oral ulcer failure rates for orthodontic brackets, elastic ligatures, molar bands, and miniscrews were noted, and periodontal characteristics were evaluated. The frequency of these failures was examined in relation to the patients' bracket systems, age, and sex.	15.42% (n=554) of all patients experienced >1 bracket bonding failure, while 8.16% (n=54) of patients who received miniscrew implantation experienced >1 miniscrew failure. Men experienced bracket bonding failure at a rate that was noticeably higher than that of women. The link between periodontal factors and bracket bonding failure was not determined to be significant. In comparison to scores published for a comparable demographic prior to a lockdown, plaque and gingival scores were greater. The findings suggested that lockdown periods may affect the patients' periodontal health state and that orthodontic appliances might have failed more frequently than usual during lockdowns.
Yavan <i>et al.</i> 2022 ^[37]	176 patients	12-30 years; 25:75	Questionnaire based study	This study's objective was to assess orthodontic patients' anxiety levels over the course of a year in the midst of a continuing pandemic. Patients undergoing fixed orthodontic treatment and ranging in age from 12 to 30 were included in the study. The questionnaire was completed by 266 patients in total between June 8 and July 8, 2020 (T0), and 176 of 190 patients (response rate: 92.63%) who were still receiving therapy completed it again between June 15 and July 16, 2021. (T1).	The State-Trait Anxiety Inventory-S score in the overall population decreased significantly, but the State-Trait Anxiety Inventory-T score remained stable. Women and people over the age of 18 had considerably greater anxiety levels at T0, while only people over the age of 18 had significantly higher anxiety scores at T1 than people under 18. The State-Trait Anxiety Inventory-S score for female patients and patients under the age of 18 years significantly decreased from T0 to T1.

2020 believe that using teledentistry is a good answer. Clinicians demonstrated that the use of teleorthodontics could merely manage functional appliances and aligners, requiring just follow-up to continue therapy. However, due to the rigorous hands-on nature of teledentistry, the advancement of multibracket therapy is constrained.

With the occasional exception of oral hygiene checks or visits to address a problem, almost all mandated follow-ups involve in-person visits.

In order to avoid cross-contamination and stop new outbreaks, dental and orthodontic care during the

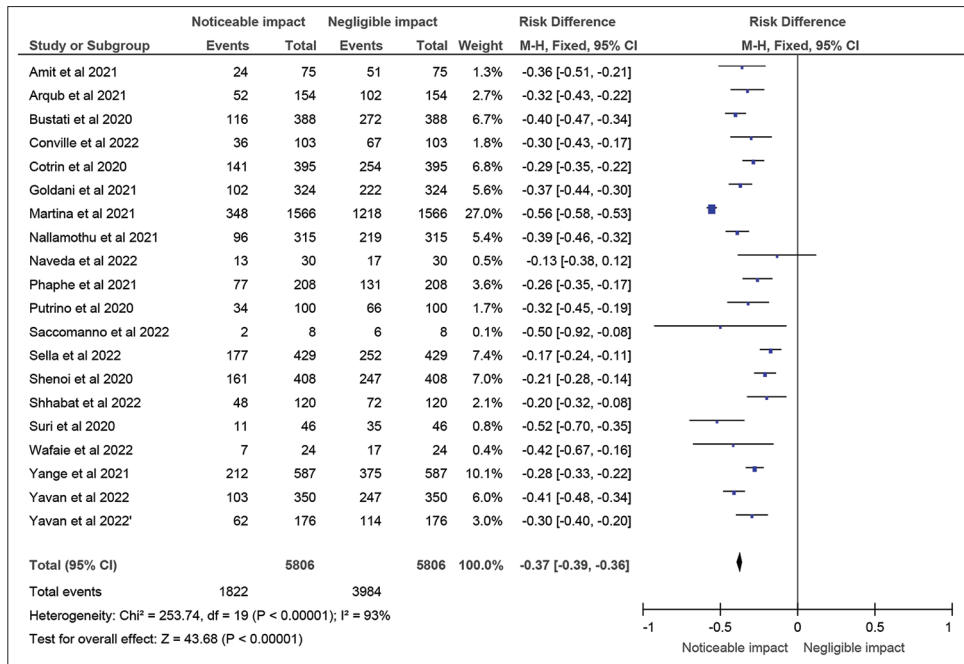


Figure 4: Risk difference of studies selected in this systematic review that assessed the impact of COVID-19 on orthodontic treatment modalities represented on a forest plot after meta-analysis

pandemic and in the future will require precautionary and selective case review based on the practitioner’s judgment.^[33] The practitioner should adhere to the instructions given by the relevant health regulatory agencies. To maintain effective ventilation, air circulation, and standard PPE, the dental clinic may need to be modified and redesigned. Until the COVID-19 pandemic is no longer a concern, efficient telescreens and triaging should be a regular part of clinical screening protocols. Deferred orthodontic treatment and a referral to the COVID-19 screening unit should be given as a top priority to any suspected COVID-19 patient who exhibits symptoms. The dental procedure should involve little contact, be minimally intrusive, and prevent the creation of aerosols. The COVID-19 epidemic has had a significant impact on orthodontists and dental health workers in general. Costs associated with running a practice have increased due to growing demand and a desire for clinical inventory. However, orthodontists and dental professionals should strike a balance between the quality of care and the associated cost. The updated standards for infection control measures and the associated costs should be fully disclosed to patients.^[38] Pre-treatment, during treatment, and after treatment, the clinic’s disinfection procedures must be rigorously followed. The health of the personnel and patients should be given first attention. The article’s suggested workflow and guidelines, which were compiled from a number of health regulatory authorities, will allow for the appropriate and efficient management of dental and orthodontic care both during the COVID-19 pandemic and in the years after it. Virtual examination is a practical

replacement for traditional examination methods, but when implementing initiatives, it’s crucial to find and create a platform that is patient-friendly. If the patient’s earlier x-rays and photographs are stored on a database system and are easy for an orthodontist to access when necessary, they can also be evaluated for reference during a virtual examination of the patient.^[39] Certain situations cannot be avoided because they will impair the mastication process and may cause food lodgments, which will then cause chewing issues. The orthodontist is unable to handle such situations, especially if traveling great distances for orthodontic consultations is involved. Therefore, those issues necessitate prompt attention from a dental doctor who practices close by.^[40,41] If the government or governing health authorities have made a provision permitting the clinician to visit a patient, the dentist may choose to attend such crises.

The lack of randomized control trials can be attributed to being a major flaw in this systematic review of ours; however, the impact of COVID-19 on the field of orthodontics as a whole has been studied and observed during the time of the pandemic and immediately after the pandemic ended, which explains the lack of these types of trials. Also, we do not believe that a long-term study concerning the impact of the pandemic on orthodontic patients/practitioners has been reported yet. Therefore, more studies are needed to ascertain the pros/cons of these emerging trends so as to establish their credibility as trends that are beneficial to not just orthodontists but patients as well.

Conclusions

Nearly every aspect of the patients' lives who were receiving orthodontic therapy was significantly impacted by COVID-19, and a majority of them faced issues such as anxiety, paranoia, and fear of going for treatment due to the COVID-19 scare. However, people receiving various orthodontic treatment approaches today did not have the same problems as patients in the past. During the pandemic-related lockdown, teleorthodontics became a feasible option for receiving therapy. The psychological well-being and morale of orthodontists all throughout the world were also adversely affected by COVID. More case control trials and original research are required to determine whether the impacts on patients are still detectable in the post-pandemic era.

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Conflicts of interest

There are no conflicts of interest.

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