

Telemedicine in the diagnosis and management of temporomandibular disorders: A systematic review conducted according to PRISMA guidelines and the Cochrane Handbook for Systematic Reviews of Interventions

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Abstract

Background: Telemedicine (T-Med) has always been an important tool in the arsenal of clinicians worldwide. This technique has become increasingly popular in recent years, especially in light of the COVID-19 pandemic, which has made it difficult for some people to access traditional dental care. The current review aimed to analyse the usage of telemedicine in the diagnosis and management of temporomandibular disorders (TMDs) and its impact on general health.

Methods: An extensive search of databases was conducted using keywords such as, “telemedicine,” “teledentistry,” “TMJ” and “temporomandibular disorders,” resulting in a total of 482 papers to be available from which eligible studies were selected. The Risk of Bias in Observational Studies of Exposures (ROBINS-E) tool was used to evaluate methodological quality of included studies.

Results: Two studies were selected which fulfilled the eligibility criteria. All assessed studies indicated varying degrees of positive outcomes for patients who were intervened for TMDs using T-Med.

Conclusion: T-Med shows promising results for the diagnosis and management of TMDs, especially since the advent of the COVID-19 pandemic and thereafter. Long-term clinical trials with larger samples are needed to further ascertain validity in this regard.

KEYWORDS

temporomandibular disorders, teledentistry, telemedicine, TMJ

1 | INTRODUCTION

Temporomandibular disorders (TMDs) are a group of conditions that can cause significant discomfort and pain in the temporomandibular joint

(TMJ) and the surrounding muscles.¹⁻⁶ These disorders can affect people of all ages, but they are more prevalent in women.^{7,8} The symptoms of TMDs include jaw pain, difficulty in opening or closing the mouth, and clicking or popping sounds when the jaw moves.⁹ In some cases,

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TMDs can also cause headaches, earaches and neck pain. The diagnosis of TMDs typically involves an in-person consultation with a dentist or a maxillofacial surgeon. The healthcare professional will evaluate the patient's symptoms, medical history, and conduct a physical examination of the TMJ to determine the cause of the disorder.⁹ Treatment for TMDs can include a range of therapies, such as pain medication, physical therapy, splints or mouthguards and surgery in severe cases.⁹

However, in recent years, there has been a growing interest in the use of telemedicine for TMDs management.^{10,11} Telemedicine, also known as telehealth, involves the use of technology to deliver healthcare services remotely.¹² T-Med allows patients to consult with healthcare professionals, receive a diagnosis and receive ongoing care without the need for in-person visits. This mode of healthcare delivery has several advantages, such as improving access to care, reducing travel time and expenses and providing care for patients who are unable to attend in-person consultations due to mobility issues or geographical barriers.

The COVID-19 pandemic has increased the use of telemedicine in many areas of medical and dentistry.^{10,12,13} Virtual consultations have aided in keeping patient access to care while also preserving medical resources, including personal protective equipment and the risk of exposure to patients and healthcare professionals.^{12,14,15} Additionally, telemedicine has contributed to the treatment of patients who live in senior and assisted living facilities as well as in underserved and rural regions.^{16,17} Saving money on medical transportation expenses and journey time for both patients and carers are additional benefits. Due to these advantages, telemedicine has developed into a useful tool for patient care across a variety of disciplines, including oral and maxillofacial surgery (OM). Prior to the COVID-19 pandemic, OM experts used telemedicine, but it was not as common as it is now.¹⁸ The application of telemedicine in OM during the pandemic has received backing from numerous studies.¹⁶⁻¹⁸

The evidence for the effectiveness of telehealth interventions in improving outcomes related to musculoskeletal pain is similar to the usual face-to-face interventions, according to a recent systematic review.¹⁹ Healthcare professionals claim that internet services can be a useful supplement to in-person therapies for chronic pain. Additionally, virtual methods of providing healthcare are well received by patients.²⁰ Following a shoulder joint replacement, patients who got exercises via T-Med described positive feelings regarding the modality.²¹ The delivery of treatments for pain-coping, exercise and cognitive behavioural therapy via telehealth was also well received by patients.²²

Hence, this systematic review was conducted to answer the research question 'Is there a difference in telemedicine in diagnosis and management of Temporomandibular disorders as compared to conventional approach?'

2 | MATERIALS AND METHODS

2.1 | Eligibility criteria

The present review assessed eligibility of the studies based on the participants, intervention, comparison and outcomes (PICO) model.

P) Population—Human subjects irrespective of age, gender and ethnicity.

E) Exposure—Exposure to TMD.

C) Comparison—Conventional treatment used for the diagnosis or treatment of TMD.

O) Outcome—Includes diagnosis, functional outcome of pain and quality of life such as loss of working hour.

Studies published in English language that focused on the use of T-Med for the diagnosis and effectiveness of T-Med interventions in improving the outcomes of TMD management. Studies that solely reported about face-to-face (conventional) interventions or usual care were not included. Case reports, case series, letters and commentaries were excluded.

2.2 | Search strategy

Databases of Pubmed, Google scholar, Web of science and Cochrane were searched for articles. MeSH term employed for the review is presented in [Table 1](#). The PRISMA²³ guidelines and the Cochrane Handbook for Systematic Reviews of Interventions were followed for the preparation of this systematic review, with the flowchart in [Figure 1](#) representing the various stages of article selection. The systematic review protocol was registered in the International Prospective Register of Systematic Reviews (PROSPERO) with number CRD42023418528.

2.3 | Data extraction

Two reviewers extracted data from the selected articles using a standardized data extraction form separately. The data extracted included the various types of variable characteristics such as author, year of publication, country, type of telemedicine consultation, sample, diagnostic criteria, outcome assessed and inference. This data extracted were then compared for ascertaining consistency, with disagreements between the reviewers being resolved by a third independent re-viewer wherever required. Then in the final step, the synthesized data were assessed for quality using a specific validated tool.

2.4 | Quality assessment

Methodological quality of included studies was measured using ROBINS - E.²⁴ The Risk of Bias in Observational Studies of Exposures (ROBINS-E) tool is a methodological tool developed to assess the risk of bias in non-randomized studies, specifically studies that investigate the effects of exposures on health outcomes, based on the Cochrane Risk of Bias tool. The ROBINS-E tool evaluates seven domains of bias: Bias due to confounding, bias in selection of participants, bias in classification of interventions, bias due to deviations from intended interventions, bias due to missing data, bias in measurement of outcomes and bias in selection of the reported

TABLE 1 Search strategy.

Databases	Keywords
Google scholar	("telemedicine" OR "telehealth" OR "remote consultation" OR "e-consultation" OR "virtual consultation" OR "video consultation") AND ("temporomandibular disorders" OR "craniomandibular disorders" OR "TMD" OR "TMJ") AND ("clinical studies")
PubMed	<ul style="list-style-type: none"> • S1*: ("telemedicine" OR "telehealth" OR "remote consultation" OR "e-consultation" OR "virtual consultation" OR "video consultation") • S2*: ("temporomandibular disorders" OR "craniomandibular disorders" OR "TMD" OR "TMJ") • S3: S1* AND S2*
Web of science	TOPIC: (("telemedicine" OR "telehealth" OR "remote consultation" OR "e-consultation" OR "virtual consultation" OR "video consultation") AND ("temporomandibular disorders" OR "craniomandibular disorders" OR "TMD" OR "TMJ"))
Cochrane	<ul style="list-style-type: none"> • S1*: ("telemedicine" OR "telehealth" OR "remote consultation" OR "e-consultation" OR "virtual consultation" OR "video consultation") • S2*: ("temporomandibular disorders" OR "craniomandibular disorders" OR "TMD" OR "TMJ") • S3: S1* AND S2*

*Wherein S1, S2 and so on represent the number of times searches were carried out in that following database.

result. Each domain is assessed for its potential risk of bias, which is classified as low, moderate, serious, or critical. The overall risk of bias for the study is then determined based on the highest risk of bias in any of the domains. Two reviewers assessed risk of bias independent of each other. In case of any non-consensus, a third reviewer was consulted.

3 | RESULTS

The keyword search of the database yielded 482 papers, from which 169 papers were chosen based on how pertinent they were to the research question. In order to ensure that the final selection contained eligible papers, 111 studies that were comparable to or duplicates of one another were eliminated. The remaining 58 papers were screened for titles and abstracts. Fifty-four articles were further rejected as they did not fit our eligibility requirements. Final selection resulted in a total of two articles.

Studies reported were one each from Sweden and Spain. Telehealth exposure in the two studies used a Web based multi-modality program for pain and Store and forward telemedicine system respectively.^{25,26} Criteria to diagnose TMD was DC/TMD in the study of Lam et al.¹⁶ The study of Salazar Fernandez et al.²⁶ did not mention the criteria for inclusion of TMD cases. Julia Lam et al.²⁵ assessed outcome related to pain while Salazar Fernandez et al.²⁶ reported on multiple outcomes of which loss in working hours was significant. All the studies showed a positive impact of telemedicine for the variables assessed. Characteristics of all studies are presented in Table 2 (Table 3 List of abbreviations).

Figure 2 represents the quality assessment of articles included. Both the studies did not mention about confounding variables. Salazar Fernandez et al. 2012²⁶ did not mention about diagnostic criteria for TMD raising some concerns in the study. The other study

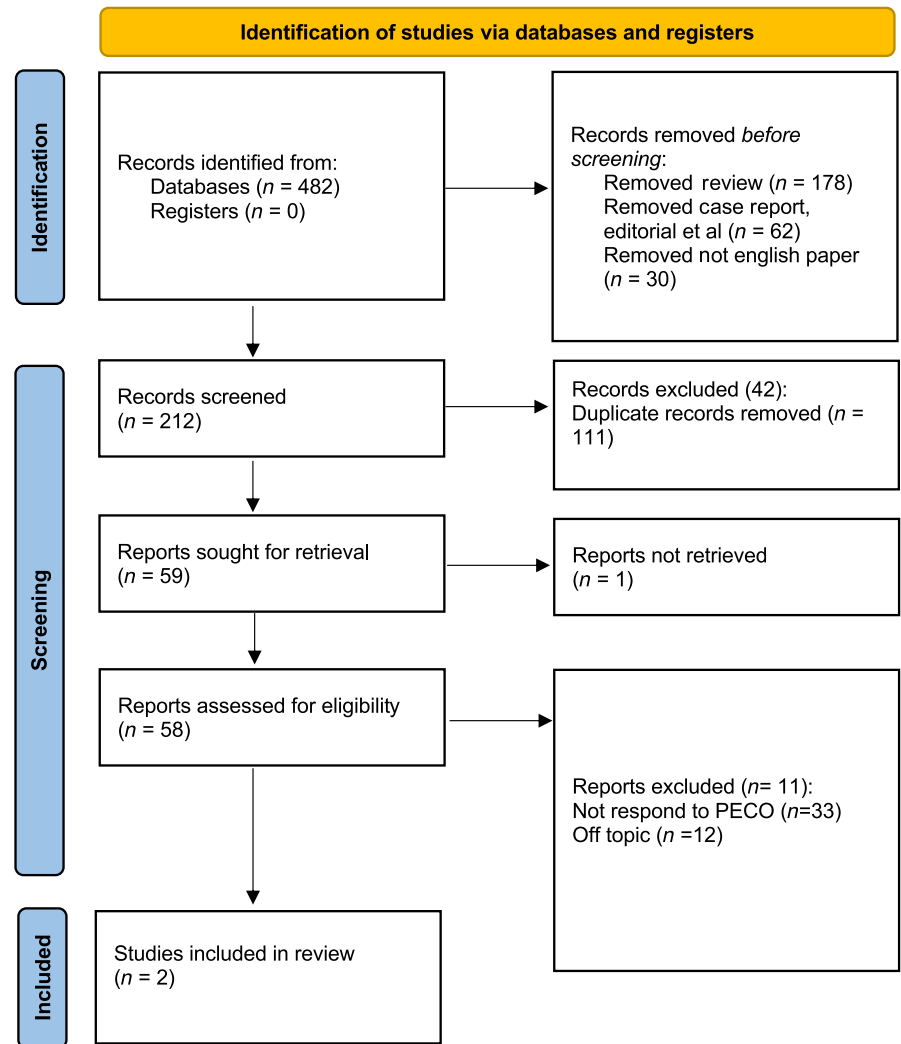
was considered to be of low risk as quality of other domains were good, thus showing lower risk of bias.¹⁶

4 | DISCUSSION

Temporomandibular disorders is a common condition that affects the jaw joint and muscles and can cause pain, difficulty chewing and other symptoms. Telemedicine, which involves the use of technology to deliver healthcare services remotely, has the potential to improve access to care, reduce costs and improve patient outcomes, as evident by the observations of our review. The systematic review involved a rigorous search of multiple databases to identify studies that investigated the use of telemedicine for TMD. The studies were evaluated for their quality and relevance to the research question, and the findings were synthesized to provide a summary of the current evidence on the effectiveness of telemedicine for TMD management.

A potential implication of this review was the considerable gap in research on telemedicine for TMD. There is a serious dearth of randomized control trials on the topic, and this highlights the need for more research in this area. This could be attributed this dearth to the highly complex nature of AI, and it might be too early to utilize this technology without accounting for its safety in relation to human trials. This could be useful for researchers and funding agencies who are interested in advancing the field of telemedicine for TMD. The review also provides insights into the types of telemedicine interventions that are most effective for TMD management. Smartphone based application, zoom based and web-based video conferencing were all found effective. This information is again useful for healthcare providers who are considering implementing telemedicine services for TMD management. Another observation of the review is that it shows that patients are most likely to benefit

FIGURE 1 Prisma flowchart.



from telemedicine for TMD as demonstrated by the betterment of signs and symptoms.

Two more studies are reported in literature assessing the same outcome, but it was in a single group and hence was not included in the review. They compared the same group between pre and post exposure to telemedicine. A study conducted in Indonesia was done on 35 dental students employing Smartphone app. Severity of TMD was assessed before and after jaw exercise. The severity of TMD in the 'mild' and 'severe' category decreased significantly at $p = .007$ and $p = .003$.¹⁸ Yet another study conducted in Brazil on 137 incident cases with a median age of 56 years assessed pain intensity after e-health exposure. It was noted that pain was reduced on 3-point median (on a 1–10 scale), which was significant at $p < .05$.¹⁹

According to Salazar Fernandez et al.,²⁶ T-Med allows accurate diagnosis and treatment for most TMD cases, shortens treatment time delays and lowers unnecessary costs for TMD patients. This was similar the findings of existing literature.^{27,28} Ricca Chairunnisa et al. promoted efficacy through self-management by using jaw exercised videos with reminders.¹⁸ This observation was consistent with another study.²⁹ Telemedicine could thus be advised over traditional for the delivery of jaw exercise treatment. Additional benefits

include low cost while maintaining quality and consistency of health care.²⁶

Certain patient related variables can affect the utilization and impact of T-Med. Gender, age and education attainment are few such factors mentioned in literature. Age has an impact on a patient's desire to have a virtual consultation, and younger generations use the online medical consultation service more frequently.^{30,31} On the contrary, as per Shenoy et al., age and gender³² had no bearing on T-Med acceptability. Educational level among the diagnostic groups in their research did not significantly differ in terms of satisfaction or diagnostic accuracy.

Since the advent of the 4G network, smartphones with advanced voice and video capabilities, and the widespread use of this tool, telemedicine has become increasingly popular.³³ Ricca Chairunnisa et al. employed smartphones for assessing severity of TMD following jaw exercises and found it to be successful.³⁴ Studies utilizing a smartphone software for remote treatment have produced varying levels of diagnostic accuracy for several oral health conditions. Fonseca et al.³³ examined the relationship between telemedicine and in-person management and used videoconferencing via the smartphone app Face Time for trauma evaluation. They reported

TABLE 2 Main characteristics of the studies included in the present systematic review.

Author	Study design	Location	Telemedicine modality	Sample	Groups	Diagnostic criteria	Outcome assessed	Interpretation
Julia Lam et al. 2020	Randomised control trial	Sweden	Web based multi-modality program for pain	43 subjects; 34 females; 9 males in the median age of 27 years, IQR – 23–37.	Test group = 20; Active control group – 23	Diagnostic criteria for temporomandibular disorders (DC/TMD)	Pain intensity, disability associated with pain, functional limitation of the jaw	A significant difference was noted for functional jaw limitation at $p = .02$ but not for other outcome, with e-health performing better than conventional treatment
Salazar Fernandez et al. 2012	Multicentric quasi experimental study	Spain	Store and forward telemedicine system	710 patients in conventional assessment with a mean age of 38.3 years and 82.7% females; 342 via telemedicine in the mean age of 38.3 years and 80.7% females	Two groups – Conventional and telemedicine based	Not mentioned	Diagnosis, Secondary consultations required, time lost and referral	Significant difference was observed for lost working hours, with 32.4 hrs lost in conventional and 16.8 hours in telegroup at $p = .01$. The other outcome assessed were equally distributed between the groups

TABLE 3 List of abbreviations.

Abbreviation	Description
DC/TMD	Diagnostic Criteria for Temporomandibular disorders
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
TMD	Temporomandibular disorder
TMJ	Temporomandibular joint
T-Med	Telemedicine

that smartphone is a viable technique with excellent agreement with in-person evaluation. However, they also acknowledged that there would likely be some challenges that would prevent the proliferation of this strategy, such as in the case of complicated soft tissue injuries. The viability of the WeChat programme for head and neck cancer follow-up patients was investigated by Lyu et al.³⁵ They recommended WeChat as a cost-effective and practical instrument to support in-person consultations in China rather than as a replacement for clinical follow-up. In yet another study, Petrucci et al.³⁶ used WhatsApp to consult clinical images and found that, in 82% of cases, telemedicine agreed with clinico-pathologic assessments. Giudice et al.³⁷ also used the WhatsApp application in their research to look into the benefits of telemedicine in dental practice for patients who needed treatment on a priority basis and for those who needed to be followed up on. They concluded that T-Med, by limiting human contact, enabled successful monitoring, cut expenses and decreased the danger of COVID-19 spread. BruxApp developed by Manfredini³⁸ is yet another Teleapp that employs a mobile software to evaluate ecological momentary symptoms of aware bruxism. The frequency of each included item (teeth clenching/grinding/soreness/contact, tension or contraction in muscles and difficulty in movements) was rated on a customized algorithm using a 5-point likert scale. This software is particularly useful to track changes over time so as to adopt timely remedial measures. Researchers can also benefit from the vast data base collected.³⁹

One of the most greatest benefits of T-Med for TMD management is its ability to improve access to care. Patients who live in remote or rural areas may not have easy access to healthcare facilities, making it difficult to receive timely diagnosis and intervention. T-Med enables healthcare professionals to provide care to patients regardless of their location, as long as they have access to a computer or smartphone and a stable internet connection.^{40,41}

Another advantage of T-Med for TMD management is its ability to reduce the burden on healthcare facilities.⁴² TMD is a prevalent condition that affects a significant proportion of population. The traditional in-person consultation method can result in long waiting periods and overcrowding in healthcare facilities. T-Med can help to reduce the number of patients who need to visit healthcare facilities, which can free up resources and reduce the risk of transmission of infectious diseases.

T-Med can also provide a more comfortable and convenient experience for patients. Many patients with TMD experience pain

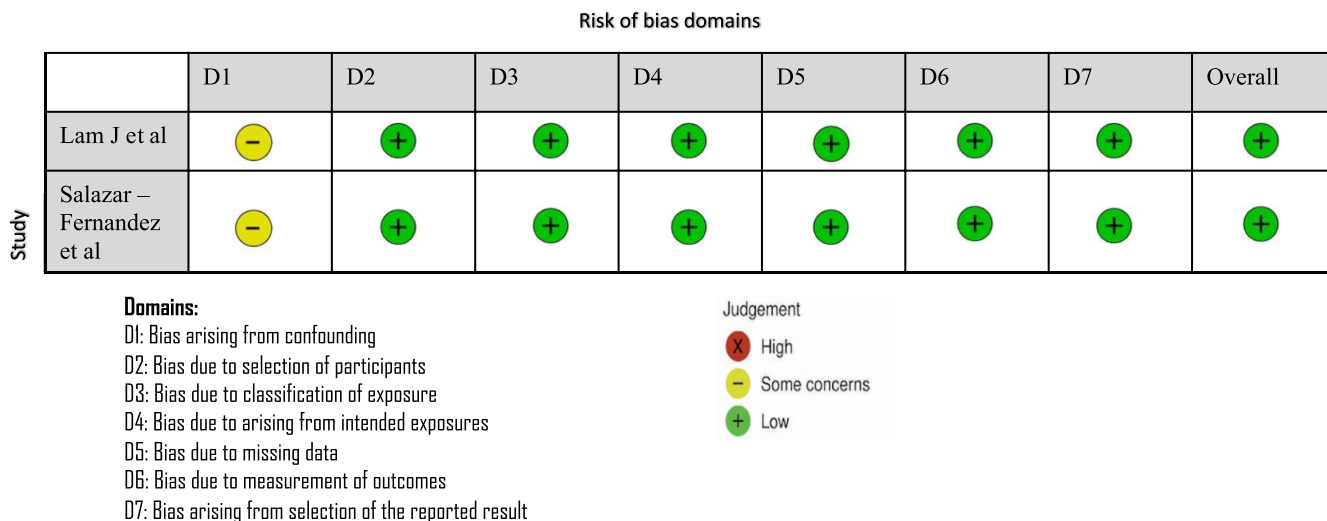


FIGURE 2 Risk of bias domains of the included studies.

and discomfort, which can make it difficult for them to attend in-person consultations. T-Med enables patients to receive care from the comfort of their homes, without the need to travel or wait in a busy healthcare facility. T-Med can be used in several ways for TMD management. One common modality is video consultations, where patients can speak with a healthcare professional via video conferencing software. During the video consultation, the healthcare professional can evaluate the patient's symptoms, provide a diagnosis and recommend appropriate treatment. Video consultations can be conducted in real-time or as a pre-recorded session, which allows patients to access care at their convenience. Mobile health applications (apps) can also be used for TMD management.^{36,37} Mobile health apps can provide patients with information about TMD, self-management strategies and exercises to alleviate symptoms. Patients can also use these apps to track their symptoms and communicate with healthcare professionals if necessary.

While telemedicine has several benefits for TMD management, it also has some limitations that healthcare professionals and patients need to be aware of. One of the main challenges of T-Med is the lack of a physical examination, which can make it challenging to diagnose some TMD conditions accurately.⁴³ Healthcare professionals may not be able to evaluate the range of motion of the jaw or assess the strength of the surrounding muscles accurately. As a result, T-Med may not be suitable for patients with severe or complex TMD conditions that require a more comprehensive evaluation.⁴⁴

Another limitation of T-Med is the possibility of technical difficulties.⁴⁵ Patients may have difficulty accessing telemedicine services if they do not have access to the necessary technology or a stable internet connection. Technical issues can also occur during a video consultation, which can lead to disruptions or delays in care delivery. Moreover, T-Med also raises issues related to patient privacy and confidentiality. Patients need to ensure that they are using secure T-Med platforms and that their personal health information is

protected. Healthcare professionals must also adhere to strict data protection regulations to ensure that patient information is kept secure. Despite these limitations, T-Med is a promising modality for TMD management. T-Med can improve access to care, reduce the burden on healthcare facilities, and provide a more comfortable and convenient experience for patients. T-Med can also provide patients with greater control over their care by enabling them to manage their symptoms and communicate with healthcare professionals more easily.

This review has some limitations to be mentioned. The systematic review identified only a few relevant studies, which could restrict the generalizability and robustness of the findings by not representing the diverse patient population. Telemedicine encompasses a wide range of platforms and technologies, such as video conferencing systems, remote monitoring devices or mobile applications. The included studies utilized different telemedicine modalities that could have probably affected the overall consistency and effectiveness of telemedicine in TMD diagnosis and management.

5 | CONCLUSION

The use of telemedicine for the management of TMD is a growing area of interest in healthcare. Telemedicine has the potential to improve access to care, reduce the burden on healthcare facilities, and provide a more convenient and comfortable experience for patients. All the studies in this review showed promise in their observations pertaining to the usage of telemedicine for management of TMD disorders. Moreover, as telemedicine evolves, it is crucial for healthcare professionals to ensure that the quality of care delivered through this modality remains high, and patient safety and confidentiality are maintained. However, we strongly advocate the need for conducting more clinical trials to fully ascertain the role of T-Med as a viable diagnostic/management tool for TMD.

CONFLICT OF INTEREST STATEMENT

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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