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ORIGINAL ARTICLE

Frequency and patterns of craniomaxillofacial surgery during and after COVID-19: analysis of the Japanese national database

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Abstract

Purpose Craniomaxillofacial (CMF) trauma is primarily associated with high-energy injuries and constitutes a significant proportion of hospital presentations in Japan. The coronavirus disease 2019 (COVID-19) pandemic and related public health restrictions profoundly altered daily life and social behavior, potentially influencing trauma patterns and surgical interventions for CMF injuries.

Methods We retrospectively analyzed nationwide data from the Japanese National Database, covering the period from 1 January 2014 to 31 December 2023. Inpatient and outpatient CMF surgical procedures were identified using procedural codes and categorized into pre-pandemic (2014–2019), pandemic (2020–2021), and post-pandemic recovery (2022–2023) periods. Statistical analysis included descriptive evaluation and comparative analysis across these periods.

Results In total, 30,398 CMF surgical procedures were recorded during the 10-year study period. The pre-pandemic period averaged 3,528.0 cases per year, which declined to 2,756.5 cases per year during the pandemic period, representing a 21.87% reduction ($p<0.001$). The post-pandemic period showed partial recovery, averaging 3,358.5 cases per year, remaining 4.80% below pre-pandemic levels. The largest pandemic-period declines were observed for bilateral mandibular condylar fracture surgery (−100%), bilateral mandibular fracture surgery (−40.5%), and non-invasive reduction of maxillary fractures (−43.8%). Notable recovery patterns emerged post-pandemic, with zygomatic fracture procedures surpassing pre-pandemic levels (+2.7%), while most other procedures remained below baseline.

Conclusion The COVID-19 pandemic significantly reduced CMF surgical procedures in Japan, with differential impacts across procedure types. The post-pandemic period reveals heterogeneous recovery patterns—some procedures exceeding pre-pandemic levels while others persistently lag—suggesting enduring changes in trauma patterns and healthcare utilization.

Keywords Craniomaxillofacial trauma · COVID-19 · Facial fractures · National database · Trauma epidemiology · Japan

Introduction

Craniomaxillofacial (CMF) injuries represent a substantial burden on healthcare systems worldwide, accounting for a significant proportion of emergency department presentations and requiring specialized surgical expertise for optimal management [1]. These injuries encompass a diverse spectrum of fractures involving the facial skeleton—including the mandible, maxilla, zygoma, orbital bones, and nasal structures—each presenting unique diagnostic and therapeutic challenges. The complexity of the facial anatomy, with its intricate relationship between the skeletal architecture, neurovascular structures, and soft tissue envelope, necessitates precise surgical planning and execution to restore both function and aesthetics.

In Japan, the epidemiology of CMF trauma has been well documented through various regional studies, revealing distinct patterns influenced by demographic factors, urbanization, and cultural practices [2]. Most CMF injuries result from high-energy trauma mechanisms, with motor vehicle

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accidents historically representing the leading cause; this is followed by falls, sports-related injuries, interpersonal violence, and occupational accidents [3]. The Japanese healthcare system has developed a robust network of specialized CMF surgical units within university hospitals and major medical centers staffed by oral and maxillofacial surgeons trained to manage these complex injuries. These units employ advanced diagnostic modalities, including high-resolution computed tomography and three-dimensional reconstruction techniques, allowing for precise fracture characterization and surgical planning. Surgical intervention remains the treatment of choice for displaced fractures, with techniques ranging from closed reduction for simple fractures to open reduction and internal fixation for complex, comminuted injuries [4].

The relationship between societal disruptions and trauma patterns has been documented in various contexts, including natural disasters and economic crises [5, 6]. Historical analyses of trauma epidemiology during the 2011 Great East Japan Earthquake [7, 8] and the 1995 Hanshin-Awaji Earthquake [9, 10] demonstrated significant alterations in both the incidence and characteristics of traumatic injuries. These precedents suggest that major societal disruptions can fundamentally alter the mechanisms, frequency, and severity of trauma presentations, with implications for healthcare resource allocation and surgical service provision.

The emergence of coronavirus disease 2019 (COVID-19) in early 2020 represented an unprecedented global health crisis that profoundly transformed daily life across Japan. Following the first confirmed case on 16 January 2020, the Japanese government implemented a series of escalating public health measures aimed at controlling viral transmission. The initial declaration of a state of emergency on 7 April 2020—covering seven prefectures and later expanded nationwide—marked the beginning of far-reaching societal changes. These measures included strong recommendations for citizens to refrain from nonessential outings, closure of entertainment venues and restaurants, cancellation of public events, and widespread adoption of telework arrangements. Schools at all levels suspended in-person instruction, sports facilities closed, and social gatherings were strongly discouraged. Unlike some countries that imposed strict lockdowns with legal penalties, Japan's approach relied primarily on voluntary compliance with government requests, reflecting cultural values of social responsibility and collective cooperation.

The pandemic's impact extended beyond immediate movement restrictions, fundamentally altering social behaviors and lifestyle patterns. The concept of *jishuku* (self-restraint) became central to Japan's pandemic response, with citizens voluntarily limiting their activities even in the absence of legal mandates [11]. This behavioral shift likely influenced trauma epidemiology through multiple mechanisms. Reduced vehicular traffic resulting from telework adoption and movement restrictions may have decreased motor vehicle–related injuries. The cancellation of organized sports and the closure of recreational facilities likely reduced sports-related trauma. Conversely, increased time spent at home may have changed the risk profile for domestic accidents, particularly among elderly populations. The phenomenon of *Corona-ka* (living under coronavirus) introduced new social dynamics that may have affected patterns of interpersonal violence and alcohol-related injuries.

As the pandemic evolved through successive waves, each characterized by different viral variants and varying public health responses, the healthcare system faced unprecedented challenges in maintaining routine surgical services while managing patients with COVID-19. Surgical departments implemented strict infection control protocols, including preoperative COVID-19 screening, enhanced personal protective equipment requirements, and modifications to surgical techniques aimed at minimizing aerosol generation. These adaptations may have influenced clinical decision-making regarding the timing and approach to CMF surgical interventions. Some institutions reported delays in nonurgent surgical procedures, raising concerns about the long-term consequences of deferred treatment for facial fractures, particularly with respect to functional outcomes and the development of malunion or nonunion complications.

The transition to the post-pandemic phase, marked by the gradual relaxation of public health measures and societal adaptation to endemic COVID-19, offers a unique opportunity to examine the lasting impacts of this global disruption on trauma patterns and surgical practice. The Japanese government's downgrading of COVID-19 to a Category 5 infectious disease in May 2023 symbolically marked the end of the emergency phase, yet questions remain as to whether trauma patterns and healthcare utilization have returned to pre-pandemic baselines or evolved into a "new normal." Understanding these dynamics is essential not only for immediate healthcare planning but also for developing resilience strategies to better prepare for future public health emergencies.

Previous international studies have begun to document the pandemic's impact on CMF trauma, with reports from Europe, North America, and other Asian countries showing variable effects depending on local contexts, healthcare systems, and public health responses [12–14]. However, comprehensive longitudinal analyses extending into the post-pandemic period remain limited, particularly those utilizing national-level data capable of capturing

population-wide trends. Japan's unique position, with its comprehensive National Database of Health Insurance Claims and Specific Health Checkups of Japan (NDB), covering nearly the entire population, along with its distinctive approach to pandemic management, provides an ideal setting to examine these questions with unprecedented scope and precision.

In this study, we performed a comprehensive analysis of the impact of COVID-19 on CMF surgical procedures in Japan using nationwide data from the NDB. By examining a decade of surgical data spanning the pre-pandemic, pandemic, and post-pandemic periods, we sought to characterize not only the immediate effects of the pandemic but also the trajectory of recovery and potential lasting changes in surgical practice patterns. Our analysis focuses on identifying differential impacts across various types of CMF procedures, exploring factors that may explain heterogeneous recovery patterns, and providing evidence-based insights to inform healthcare policy and resource allocation during both the ongoing recovery phase and future public health emergencies.

Methods and analysis

Data acquisition

This retrospective study used data from the NDB, which contains comprehensive information on all medical procedures performed under the national health insurance system. The NDB covers approximately 98% of the Japanese population and includes detailed procedural codes, costs, and annual case numbers. Data were extracted for all CMF-related surgical procedures performed between 1 January 2014 and 31 December 2023. The study included all CMF-related procedures of relevance to the field that were billed during this period.

COVID-19–related time periods

The study period was divided into three main cohorts: the 6-year pre-pandemic period (1 January 2014–31 December 2019), the 2-year pandemic period (1 January 2020–31 December 2021), and the 2-year post-pandemic recovery period (1 January 2022–31 December 2023).

The year 2020 was designated as the beginning of the pandemic period based on the first confirmed COVID-19 case in Japan (16 January 2020) and the subsequent implementation of public health measures. The post-pandemic recovery period reflects the gradual relaxation of restrictions and Japan's societal adaptation to endemic COVID-19.

Surgical procedures of interest

We investigated the number of surgeries based on K-code data from the NDB files. A K-code is a unique procedural classification used by the Ministry of Health, Labour and Welfare in Japan [15]. The raw data are presented in Supplementary Table 1. Major categories included zygomatic/midface procedures, mandibular procedures (including condylar fracture surgery), maxillary procedures, and complex procedures involving multiple facial bones. CMF surgeries are classified under codes K427 to K434 in the NDB system, and the following procedures were analyzed in this study:

Zygomatic/midface procedures

- Open reduction of zygomatic fractures.
- Zygomatic deformity correction surgery for fracture healing.

Mandibular procedures

- Non-surgical reduction of mandibular fractures (conservative).
- Open surgery for mandibular fractures (unilateral and bilateral).
- Open surgery for mandibular condylar fractures (unilateral and bilateral).

Maxillary procedures

- Non-invasive reduction of maxillary fractures (conservative).
- Open surgery for maxillary fractures.

Complex procedures

- Open surgery for multiple facial fractures.
- Corrective surgery for deformed healing of multiple facial fractures.

Statistical analysis

Descriptive statistics were calculated for all procedures, including annual case numbers and period averages. Percentage changes between the pre-pandemic, pandemic, and post-pandemic recovery periods were computed. Statistical significance was assessed using chi-square tests for categorical variables and t-tests for continuous variables,

with $p<0.05$ considered statistically significant. Recovery patterns were analyzed by comparing post-pandemic levels with both pre-pandemic baselines and pandemic-period values. All statistical analyses were performed using JMP Pro version 17 (SAS Institute Inc., Cary, NC, USA).

Results

General alterations

During the 10-year study period (2014–2023), 30,398 CMF surgical procedures were recorded. The pre-pandemic period (2014–2019) recorded 21,168 procedures (average: 3,528.0 cases per year), the pandemic period (2020–2021) recorded 5,513 procedures (average: 2,756.5 cases per year), and the post-pandemic recovery period (2022–2023) recorded 6,717 procedures (average: 3,358.5 cases per year) (Fig. 1).

The pandemic period demonstrated a significant 21.87% reduction compared with the pre-pandemic period ($p<0.001$) (Table 1). The post-pandemic period showed substantial recovery, with a 21.84% increase from pandemic levels, although it remained 4.80% below the pre-pandemic baseline ($p<0.05$) (Table 1).

Zygomatic fractures

Open reduction of zygomatic fractures was the most common CMF surgical procedure throughout the study period (Table 2). The pre-pandemic average was 2,352.7 cases per year, which decreased to 1,915.0 cases per year during the pandemic (−18.6%, $p<0.001$), then recovered to 2,416.0 cases per year post-pandemic—exceeding pre-pandemic levels by 2.7% (p=NS). This represents the most complete recovery observed among all procedure types. Zygomatic deformity correction surgery for fracture healing showed a more pronounced decline during the pandemic, from 32.3 to 23.5 cases per year (−27.3%, $p<0.05$), with partial recovery to 28.0 cases per year post-pandemic, remaining 13.4% below baseline.

Mandibular fractures

All categories of mandibular fracture surgery showed significant reductions during the pandemic, with variable patterns of recovery thereafter (Table 2):

- Non-surgical reduction: decreased from 146.3 to 108.0 cases per year during the pandemic (−26.2%, $p<0.001$), recovering to 117.0 cases per year post-pandemic (−20.0% from baseline).

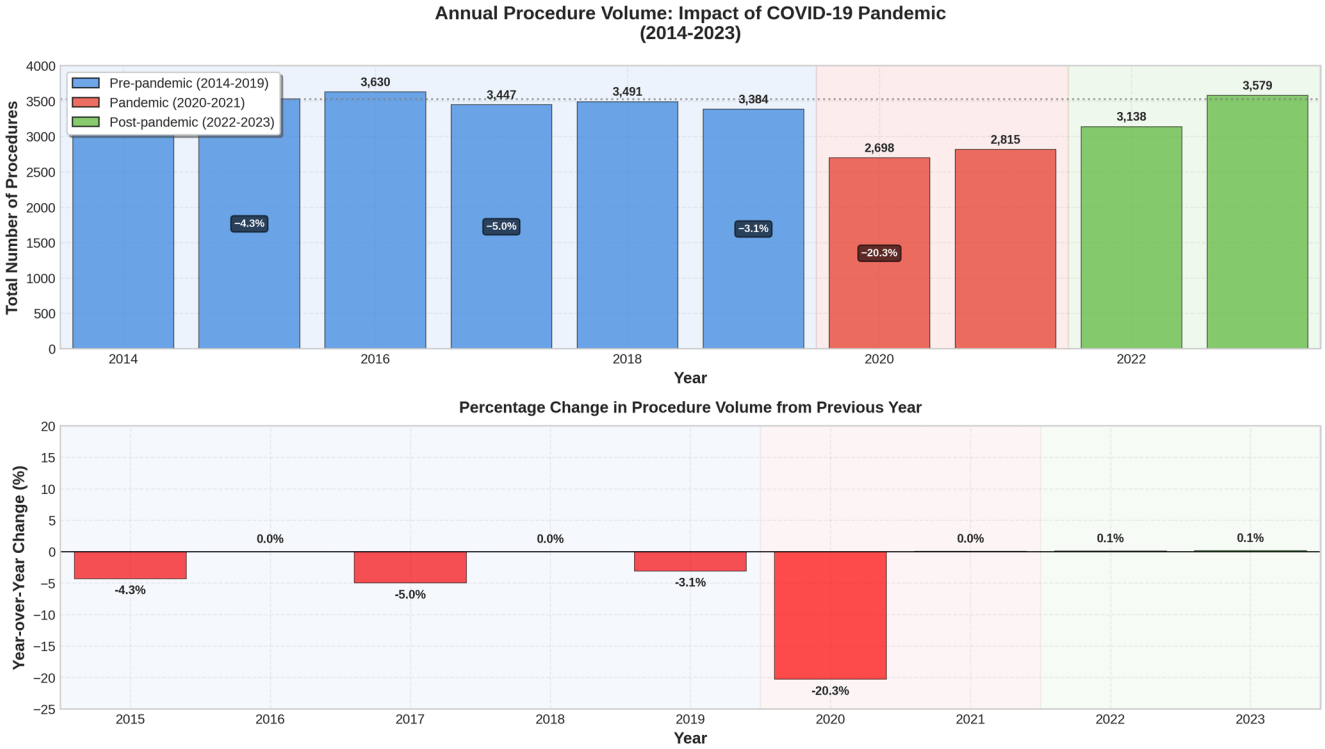


Fig. 1 Annual distribution of craniomaxillofacial surgical procedures in Japan (2014–2023)

Table 1 Comparison of craniomaxillofacial surgical volumes by period

Period	Years	Total number of procedures	Average annual number of procedures	Change from pre-pandemic
Pre-pandemic	2014–2019	21,168	3,528.0	-
Pandemic	2020–2021	5,513	2,756.5	−21.87%
Post-pandemic	2022–2023	6,717	3,358.5	−4.80%
Total	2014–2023	30,398	3,039.8	-

- Open surgery (unilateral): decreased from 240.5 to 180.0 cases per year during the pandemic (−25.2%, $p<0.001$), recovering to 192.5 cases per year post-pandemic (−20.0% from baseline).
- Open surgery (bilateral): decreased from 97.5 to 58.0 cases per year during the pandemic (−40.5%, $p<0.001$), recovering to 82.0 cases per year post-pandemic (−15.9% from baseline).
- Condylar fracture surgery (unilateral): decreased from 57.2 to 47.5 cases per year during the pandemic (−16.9%, $p<0.05$), with minimal recovery to 48.5 cases per year post-pandemic (−15.2% from baseline).
- Condylar fracture surgery (bilateral): declined from 10.0 to 0.0 cases per year during the pandemic (−100%, $p<0.01$), then rebounded to 14.0 cases per year post-pandemic (+40.0% from baseline).

The complete absence of bilateral condylar fracture surgeries during the pandemic period, followed by above-baseline recovery, is particularly noteworthy.

Maxillary fractures

Maxillary fracture procedures showed substantial decreases during the pandemic, followed by partial recovery (Table 2):

- Non-invasive reduction: decreased from 13.3 to 7.5 cases per year during the pandemic (−43.8%, $p<0.05$), recovering to 11.0 cases per year post-pandemic (−17.5% from baseline).
- Open surgery: decreased from 209.8 to 144.0 cases per year during the pandemic (−31.4%, $p<0.001$), recovering to 161.0 cases per year post-pandemic (−23.3% from baseline).

Multiple facial fractures

Open surgery for multiple facial fractures decreased from 362.5 to 268.0 cases per year during the pandemic (−26.1%, $p<0.001$), recovering to 288.5 cases per year post-pandemic (−20.4% from baseline) (Table 2). Corrective surgery for deformed healing showed a modest decline during the pandemic, from 5.8 to 5.0 cases per year (−14.3%, p = NS), but disappeared entirely in the post-pandemic period (0.0 cases per year).

Discussion

This comprehensive 10-year analysis of Japanese national data demonstrates both the immediate impact of the COVID-19 pandemic on CMF surgical procedures and the subsequent recovery patterns. The overall 21.87% reduction

Table 2 Changes in craniomaxillofacial surgical procedures by type across study period

Procedure type	Pre-pandemic average (2014–2019)	Pandemic average (2020–2021)	Change	Post-pandemic average (2022–2023)	Change from pre-pandemic	Recovery from pandemic
Zygomatic Procedures						
Open reduction of zygomatic fracture	2,352.7	1,915.0	−18.6%***	2,416.0	+2.7%	+26.2%
Zygomatic deformity correction	32.3	23.5	−27.3%*	28.0	−13.4%	+19.1%
Mandibular Procedures						
Non-surgical reduction	146.3	108.0	−26.2%***	117.0	−20.0%**	+8.3%
Open surgery (unilateral)	240.5	180.0	−25.2%***	192.5	−20.0%**	+6.9%
Open surgery (bilateral)	97.5	58.0	−40.5%***	82.0	−15.9%*	+41.4%
Condylar fracture (unilateral)	57.2	47.5	−16.9%*	48.5	−15.2%*	+2.1%
Condylar fracture (bilateral)	10.0	0.0	100.0%**	14.0	+40.0%	N/A
Maxillary Procedures						
Non-invasive reduction	13.3	7.5	−43.8%*	11.0	−17.5%	+46.7%
Open surgery	209.8	144.0	−31.4%***	161.0	23.3%***	+11.8%
Complex Procedures						
Multiple facial fractures	362.5	268.0	−26.1%***	288.5	−20.4%***	+7.6%
Corrective surgery for deformed healing	5.8	5.0	−14.3%	0.0	−100.0%**	−100.0%*
Total	3,528.0	2,756.5	−21.87%***	3,358.5	−4.80%*	+21.84%

*$p<0.05$, **$p<0.01$, ***$p<0.001$

during the pandemic period aligns with similar observations from international studies, while the post-pandemic recovery to within 4.80% of baseline suggests a resilient yet incomplete restoration of surgical volumes.

Pandemic impact and recovery patterns

The heterogeneous recovery patterns observed across different procedure types provide valuable insight into evolving trauma mechanisms and healthcare utilization. Zygomatic fracture procedures—the most common CMF surgery—showed complete recovery, even exceeding pre-pandemic levels by 2.7%. This trend may reflect a combination of catch-up effects for previously delayed cases and shifts in trauma patterns as society resumed normal activities.

By contrast, most mandibular and maxillary procedures demonstrated sustained reductions even in the post-pandemic period, remaining 15%–23% below baseline. This continued decline suggests more fundamental changes in either trauma incidence or clinical management practices that have persisted beyond the acute phase of the pandemic.

Impact on healthcare delivery and patient care pathways

The pandemic fundamentally altered the delivery of CMF surgical services in ways that extended beyond simple changes in case volume. Emergency departments implemented stringent triage protocols that may have influenced the threshold for surgical intervention [16]. Many institutions adopted a "watchful waiting" approach for borderline cases, particularly those involving minimally displaced fractures that might have received immediate surgical management in the pre-pandemic era. These more conservative approaches likely contributed to the observed reduction in surgical volumes and may have established new treatment paradigms that persist beyond the pandemic period [17].

Changes in trauma mechanisms

The implementation of stay-at-home orders, remote work arrangements, and restrictions on social gatherings fundamentally altered daily activities associated with CMF trauma risk during the pandemic period. The Japan National Police Agency reported significant reductions in traffic accidents during 2020–2021, which directly correlate with the observed decrease in trauma-related surgeries. Internationally, concerns were raised about an increase in domestic violence against women; however, the available data do not capture these implications [18]. In the post-pandemic period, normal activities have partially resumed, yet our findings suggest that certain behavioral changes may have persisted. The continued prevalence of remote work, altered commuting patterns, and modified recreational activities may contribute to the sustained reduction observed in specific trauma types.

Socioeconomic and demographic considerations

The pandemic's impact on CMF surgical volumes likely varied across demographic groups, though our national-level data cannot capture these nuances. Elderly populations—particularly vulnerable to COVID-19—exhibited marked behavioral changes characterized by increased caution and reduced outdoor activity. Such risk-averse behaviors may have contributed to the observed decline in fall-related injuries within this demographic [19]. Conversely, younger populations experiencing "pandemic fatigue" may have engaged in higher-risk behaviors during the recovery period, potentially explaining the rebound observed in certain procedure types.

Economic factors also played a significant role. The Japanese government's economic support measures, including employment subsidies and direct payments, may have mitigated some of the broader financial impacts. However, residual economic uncertainty could still be contributing to the incomplete recovery observed in overall surgical volumes.

Differential impact by procedure type

The complete absence of bilateral mandibular condylar fracture surgeries during the pandemic period, followed by an above-baseline recovery (14.0 cases per year, +40% from pre-pandemic), suggests that these complex injuries—often resulting from high-energy trauma—became extremely rare under pandemic restrictions but have since rebounded strongly. This pattern may reflect pent-up demand for high-risk activities or delayed presentation of cases.

The relatively complete recovery of zygomatic fracture procedures likely reflects their association with lower-energy mechanisms, such as simple falls, which continued to occur despite pandemic restrictions and have since returned to normal patterns. Conversely, the disappearance of corrective surgery for deformed healing of multiple facial fractures in the post-pandemic period is concerning and may indicate changes in follow-up care practices or healthcare resource allocation.

Implications for surgical training and skill maintenance

The sustained reduction in CMF surgical volumes carries significant implications for surgical education and skill

maintenance. Residents and fellows faced markedly fewer operative opportunities during their training, which inevitably affected both competency development and surgical confidence. Our finding of a 40.5% reduction in bilateral mandibular fracture surgeries during the pandemic period represents not only a statistical decline but also a tangible loss of critical training experiences in complex surgical techniques.

The educational environment also shifted because of changes in the case mix distribution [20]. Zygomatic fracture procedures being relatively preserved compared with complex mandibular surgeries may have created an imbalanced training landscape, with trainees gaining disproportionate experience in certain procedures while lacking exposure to others. This educational gap may have long-term implications for the quality of CMF surgical care, particularly for complex cases requiring advanced technical proficiency.

The post-pandemic period presents an opportunity to reimagine surgical education by integrating innovations developed during the pandemic, such as virtual reality simulations and collaborative online learning platforms, to help mitigate these training disparities.

Comparison with international data

International studies consistently demonstrate a decline in hospital-presenting trauma cases during the pandemic period, with CMF injuries showing particularly notable reductions [21, 22]. Our findings reveal a more pronounced decrease (− 21.87%) compared with the findings of the German study by Thoenissen et al. (− 14.66%) [12]. Similarly, an Italian multicenter study reported a 69.1% reduction in facial fracture presentations during the initial lockdown period [17]. A UK-Australia comparative study found a 30% reduction in Australia and a 73% reduction in the UK [23], highlighting that the severity of reductions correlated with the stringency of public health measures across different countries.

The post-pandemic recovery patterns add further context, suggesting that while the immediate impacts varied across countries, recovery trajectories likely depend on multiple factors—including the duration and strictness of public health measures, cultural differences in compliance and behavioral adaptation, healthcare system structure and resilience, and the pace of economic recovery.

Clinical and policy implications

The persistent reduction in CMF surgical volumes carries several important implications for healthcare systems. Resource allocation has become a critical concern because reductions during the pandemic initially enabled healthcare institutions to redirect resources toward COVID-19 care. However, the incomplete recovery of surgical volumes highlights the ongoing need to carefully adjust surgical capacity and resource distribution to meet evolving demands.

The sustained decline in certain complex procedures also raises serious concerns about maintaining surgical expertise within the field. This reduction risks limiting training opportunities for residents and fellows, potentially impacting the development of the next generation of CMF surgeons. The economic implications are likewise significant because each CMF procedure entails substantial costs ranging from ¥12,400 to ¥470,200 (approximately $84 to $3,185). Consequently, the reduction in surgical volumes has produced a notable financial impact on healthcare institutions that depend on these procedures as part of their revenue streams.

These insights into the shifts in surgical volumes during the pandemic provide valuable lessons for future contingency planning and can support more adaptive resource management in future public health emergencies. Perhaps most importantly, the findings suggest that some pandemic-induced behavioral changes have become lasting features of healthcare utilization. This reality necessitates long-term adjustments in both healthcare service planning and trauma care provision to better align with these emerging patterns of patient behavior and healthcare delivery.

Limitations

This study has several limitations that should be considered when interpreting the results. The NDB does not include information on trauma mechanisms or patient demographics, limiting the ability to identify underlying causes of the observed changes in surgical volumes. In addition, outpatient procedures and conservatively managed cases are not captured in the database, potentially leading to an underestimation of the overall burden of CMF injuries. Regional variations within Japan could not be assessed because of the aggregated nature of the national data, preventing the identification of geographic disparities in pandemic impact and recovery. Furthermore, the post-pandemic analysis covers only 2022–2023; longer-term monitoring will be required to fully characterize persistent or delayed effects. Finally, changes in clinical decision-making and thresholds for surgical intervention cannot be directly evaluated using the available data, although these factors likely contributed to the observed trends.

Conclusion

This 10-year analysis demonstrates that the COVID-19 pandemic led to a significant 21.87% reduction in CMF surgical procedures in Japan during 2020–2021, with differential impacts across procedure types. The post-pandemic period (2022–2023) shows heterogeneous recovery patterns, with overall surgical volumes returning to within 4.80% of pre-pandemic levels. While some procedures, such as zygomatic fracture reductions, have fully recovered or exceeded baseline, others continue to show persistent reductions—suggesting lasting changes in trauma patterns and healthcare utilization.

These findings offer important insights into both the acute effects of the pandemic and the trajectory of recovery for specialized surgical services. The incomplete recovery and variation across procedure types indicate that healthcare systems may need to adapt to a "new normal" rather than anticipate a full return to pre-pandemic conditions. Continued monitoring will be essential to track long-term trends and guide evidence-based healthcare planning in the post-pandemic era.

Abbreviations

CMF	craniomaxillofacial
COVID-19	coronavirus disease 2019
NDB	National Database of Health Insurance Claims and Specific Health Checkups of Japan

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Author contributions Yasumasa Kakei collected and analyzed the data, wrote the main manuscript, and prepared the figure and tables. Philipp Thoenissen revised the manuscript. Masaya Akashi and Robert Sader interpreted the data and supervised this research. All authors have reviewed the results and approved the submitted version of the manuscript and figures.

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Data availability The datasets generated and/or analyzed during the current study are publicly available. The original NDB data used in this study are publicly accessible through the Ministry of Health, Labour and Welfare website: https://www.mhlw.go.jp/stf/seisakunitsuite/bunya/0000177182.html.

Declarations

Ethics approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee.

Consent for publication Not applicable.

Consent to participate The requirement for informed consent was waived because the study used anonymized secondary data from the NDB.

Competing interests The authors declare no competing interests.

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References

1. Mühlenfeld N, Thoenissen P, Verboket R, Sader R, Marzi I, Ghanaati S. Combined trauma in craniomaxillofacial and orthopedic-traumatological patients: the need for proper interdisciplinary care in trauma units. Eur J Trauma Emerg Surg. 2022;48:2521.
2. Eiji Kato K, Kurohara Hwakabayashi, Kutsuna T. Nariaki Yanagase, Naoya arai: transition of maxillofacial fracture treatment in oral and maxillofacial surgery in Japan—A systematic review of related articles from the past 52 Years—. Japanese Soc Oral Maxillofacial Traumatol. 2019;18:21. (In Japanese).
3. Khan TU, Rahat S, Khan ZA, Shahid L, Banouri SS, Muhammad N. Etiology and pattern of maxillofacial trauma. PLoS ONE. 2022;17:e0275515.
4. Sukegawa S, Kanno T, Masui M, Sukegawa-Takahashi Y, Kishimoto T, Sato A, Furuki Y. A retrospective comparative study of mandibular fracture treatment with internal fixation using reconstruction plate versus miniplates. J Craniomaxillofac Surg. 2019;47:1175.
5. de la Fuente VS, López MA, González IF, Alcántara OJ, Ritzel DO. The impact of the economic crisis on occupational injuries. J Saf Res. 2014;48:77.
6. DiMaggio CJ, Avraham JB, Lee DC, Frangos SG, Wall SP. The epidemiology of emergency department trauma discharges in the united States. Acad Emerg Med. 2017;24:1244.
7. Yamanouchi S, Sasaki H, Tsuruwa M, Ueki Y, Kohayagawa Y, Kondo H, Otomo Y, Koido Y, Kushimoto S. Survey of preventable disaster death at medical institutions in areas affected by the great East Japan earthquake: a retrospective preliminary investigation of medical institutions in Miyagi Prefecture. Prehosp Disaster Med. 2015;30:145.
8. Sato K, Kobayashi M, Ishibashi S, Ueda S, Suzuki S. Chest injuries and the 2011 great East Japan earthquake. Respir Investig. 2013;51:24.
9. Kuwagata Y, Oda J, Tanaka H, Iwai A, Matsuoka T, Takaoka M, Kishi M, Morimoto F, Ishikawa K, Mizushima Y, Nakata Y, Yamamura H, Hiraide A, Shimazu T, Yoshioka T. Analysis of 2,702 traumatized patients in the 1995 Hanshin-Awaji earthquake. J Trauma. 1997;43:427.
10. Oda J, Tanaka H, Yoshioka T, Iwai A, Yamamura H, Ishikawa K, Matsuoka T, Kuwagata Y, Hiraide A, Shimazu T, Sugimoto

H. Analysis of 372 patients with crush syndrome caused by the Hanshin-Awaji earthquake. J Trauma. 1997;42:470.
11. Kobayashi G, Sugasawa S, Tamae H, Ozu T. Predicting intervention effect for COVID-19 in japan: state space modeling approach. Biosci Trends. 2020;14:174.
12. Thoenissen P, Ditt L, Terwey P, Leiblein M, Ghanaati S, Sader R, Friedrichson B. Frequency and patterns of CMF emergency cases during and after COVID-19. Eur J Trauma Emerg Surg. 2025;51:283.
13. Ahuja S, Shah P, Mohammed R. Impact of COVID-19 pandemic on acute spine surgery referrals to UK tertiary spinal unit: any lessons to be learnt? Br J Neurosurg. 2021;35:181.
14. Campagnoli M, Cerasuolo M, Renna M, Dell'Era V, Valletti PA, Garzaro M. ENT referral from emergency department during COVID-19: A Single-Center experience. Ear Nose Throat J. 2023;102:Np95.
15. Chikuda H, Yasunaga H, Horiguchi H, Takeshita K, Kawaguchi H, Matsuda S, Nakamura K. Mortality and morbidity in dialysis-dependent patients undergoing spinal surgery: analysis of a National administrative database in Japan. J Bone Joint Surg Am. 2012;94:433.
16. Elective surgery cancellations. Due to the COVID-19 pandemic: global predictive modelling to inform surgical recovery plans. Br J Surg. 2020;107:1440.
17. Salzano G, Dell'Aversana Orabona G, Audino G, Vaira LA, Trevisiol L, D'Agostino A, Pucci R, Battisti A, Cucurullo M, Ciardiello C, Barca I, Cristofaro MG, De Riu G, Biglioli F, Valentini V, Nocini PF, Califano L. Have there been any changes in the epidemiology and etiology of maxillofacial trauma during the COVID-19 pandemic? An Italian multicenter study. J Craniofac Surg. 2021;32:1445.
18. Hoehn-Velasco L, Silverio-Murillo A, de la Miyar JRB. The great crime recovery: crimes against women during, and after, the COVID-19 lockdown in Mexico. Econ Hum Biol. 2021;41:100991.
19. Yeung AWK, Tosevska A, Klager E, Eibensteiner F, Tsagkaris C, Parvanov ED, Nawaz FA, Völkl-Kernstock S, Schaden E, Kletecka-Pulker M, Willschke H, Atanasov AG. Medical and Health-Related misinformation on social media: bibliometric study of the scientific literature. J Med Internet Res. 2022;24:e28152.
20. Huntley RE, Ludwig DC, Dillon JK. Early effects of COVID-19 on oral and maxillofacial surgery residency Training-Results from a National survey. J Oral Maxillofac Surg. 2020;78:1257.
21. Lorenz FJ, Rothka AJ, Schopper HK, Lighthall JG. Impact of the COVID-19 pandemic on the Incidence, Etiology, Demographics, and treatment of craniomaxillofacial trauma. Otolaryngol Head Neck Surg. 2025;172:444.
22. Ludwig DC, Nelson JL, Burke AB, Lang MS, Dillon JK. What is the effect of COVID-19-Related social distancing on oral and maxillofacial trauma? J Oral Maxillofac Surg. 2021;79:1091.
23. Hoffman GR, Walton GM, Narelda P, Qiu MM, Alajami A. COVID-19 social-distancing measures altered the epidemiology of facial injury: a united Kingdom-Australia comparative study. Br J Oral Maxillofac Surg. 2021;59:454.

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