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Original Article

Mapping research trends of psychological status on temporomandibular disorders: A two-decade bibliometric overview

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Abstract

Aim: Research on temporomandibular disorders (TMD) has increased rapidly over the past two decades. Studies have evolved from a biomechanical framework to an understanding centered on psychosocial factors. However, the global research map of the literature has not been evaluated using bibliometric methods. The primary objective of this study is to map the bibliometric landscape of the literature addressing psychological status in TMD between 2004 and 2024, and to identify research trends, the most influential publications, authors, countries.

Materials and Methods: The study's dataset was obtained from the WOS Core Collection database. After applying the specified exclusion criteria, 1272 articles and review articles published between 2004 and 2024 were included in the analysis. The bibliometric analysis was carried out using the VOSviewer software. Annual output, country productivity, co-authorship, citation patterns, and keyword co-occurrence were assessed.

Results: A significant increase in the number of publications was observed, particularly accelerating after 2014 and peaking in recent years. Ohrbach R., Lobbezoo F., and Svensson P. were at the center of research networks, while the most cited study was conducted by Schiffman E. and colleagues, who introduced the diagnostic criteria for TMD. While the USA held a quantitative lead in scientific output, a dynamic and multi-centered collaboration network also emerged, involving Italy, Brazil, and several European countries. Studies focusing on "diagnostic criteria" in the early stages have gradually given way to psychosocial and patient-centered themes such as "depression", "anxiety", "chronic pain" and "quality of life".

Conclusion: This study presents evidence-based findings through bibliometric analysis, highlighting an increase in scientific literature addressing the psychological status in TMD over the past 20 years. It identifies the most influential authors, publications, countries, international collaborations, and research trends. Recent TMD research trends suggest a shift towards a comprehensive biopsychosocial model emphasizing the prevention of disability.

Keywords: Anxiety, bibliometric analysis, depression, psychological stress, temporomandibular disorders

INTRODUCTION

Temporomandibular disorders (TMD) are an umbrella term that encompasses a group of musculoskeletal and neuromuscular disorders characterized by clinical symptoms affecting the masticatory muscles, temporomandibular joint, and associated anatomical structures [1]. Although the etiology of TMD has long been attributed primarily to occlusal and mechanical factors, current scientific evidence strongly suggests that these approaches alone are insufficient, and the field is evolving towards a psychosocial model [2]. With its high prevalence in the general population, TMD presents not only as an individual health issue but also as a significant public health problem. This condition can significantly reduce patients' quality of life and result in substantial socioeconomic costs [3].

Psychological factors, general joint and muscle disorders, and various chronic diseases can be underlying causes of TMD [4]. It is increasingly recognized that psychological conditions such as stress, anxiety, and depression can be both a trigger and a result of TMD symptoms [5]. For example, psychological stress can lead to an increase in parafunctional habits, such as bruxism, which causes

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excessive fatigue in the masticatory muscles and places abnormal loads on the joint. It can also affect pain perception and modulation pathways in the central nervous system, thereby lowering the patient's pain threshold [6]. A systematic review by Santos and colleagues suggests a significant association between anxiety and TMD [7]. Similarly, depression is more common and severe in patients with TMD, particularly those with the myofascial pain, and it contributes to both chronic nature of the pain experience and a reduction in the patient's quality of life [8]. Determinants of high pain-related disability are linked to psychosocial factors such as severe depression, somatization, chronic pain, and treatment-seeking behavior [9]. TMD severity has been shown to have significant relationships with jaw pain, neck disability, headache, anxiety, and sleep quality [10].

Findings of OPPERA (Orofacial Pain: Prospective Evaluation and Risk Assessment) studies suggest that psychological factors play a significant role in the development and severity of TMD [11-13]. The risk of developing first-onset TMD is significantly higher in individuals with high levels of psychological stress, anxiety, depression, and somatization. Psychological factors are a strong predictor of TMD onset [13]. Somatic and psychological symptoms emerged as a robust risk factor for TMD. Several psychological variables predicted increased risk of TMD, including reported somatic symptoms, psychosocial stress, and affective distress [11]. This situation demonstrates that the pain experience is shaped not only by peripheral factors but also by psychosocial processes. Findings from OPPERA's genetic studies have defined various disrupted biological pathways related to inflammation, pain processing and psychological function, suggesting that TMD should be regarded as a multisystem disorder rather than an isolated jaw or dental disorder [4,13].

There are time-dependent changes in the biopsychosocial characteristics associated with TMD [12]. A bibliometric study on TMD has highlighted focus areas, including anatomical factors, symptoms, biopsychosocial factors, and epidemiology in TMD. Psychological factors such as depression, anxiety, and stress are among the prominent keywords [14]. However, the general trends of publications, influential authors, collaboration networks, and research trends in this field have not yet been comprehensively evaluated with bibliometric techniques. Bibliometric analyses are a powerful methodological tool for revealing the structural characteristics, global distribution, and development trends of studies on a specific topic [15,16]. In this context, understanding the development of scientific interaction between TMD and psychological status on a global scale is crucial for future research. Therefore, the present study aims to analyze the scientific literature on psychological state in TMD over the past 20 years using bibliometric methods, mapping global research trends, the most influential publications, authors, countries, and collaboration networks in this field.

MATERIAL AND METHOD

The Web of Science Core Collection database, considered the gold standard for mapping scientific research due to its comprehensive and interdisciplinary nature, was used for data collection. The search strategy was created by combining two sets of keywords with the Boolean operator "AND." The first set contained terms describing temporomandibular disorders [TS=("temporomandibular disorders" OR "temporomandibular disorder" OR "temporomandibular joint (TMJ) disorders" OR "temporomandibular joint (TMJ) disorder" OR "temporomandibular joint disorder" OR "temporomandibular joint disorders" OR "temporomandibular joints disorders" OR "craniomandibular disorders" OR "craniomandibular disorder" OR "myogenous TMDs" OR "myogenous TMD" OR "temporomandibular dysfunction" OR "temporomandibular joint disease" OR "temporomandibular joint diseases" OR “temporo-mandibular joint disorders” OR “temporomandibular joint dysfunction” OR “temporal mandibular disorder” OR “temporomandibular diseases” OR “temporomandibular dysfunctions” OR “TMJ disorders” OR “TMJ dysfunction” OR “TMJ syndrome”), while the second cluster included terms expressing psychological status [TS=("psychological stress" OR "anxiety" OR "depression" OR "psychological distress" OR "psychological health” OR "mood disorders" OR "psychological disorder" OR "psychological status" OR "psychological symptoms" OR "psychological assessment" OR "psychological well-being" OR "psychological profile" OR "psychological comorbidity")]

As a result of the comprehensive search, 1522 records were initially identified. These records underwent a systematic screening process based on exclusion criteria. First, publications outside the 2004–2024 time frame, which was the focus of the study, were excluded, resulting in a reduced number of publications to 1312. After selecting the document types "Article" and "Review Article" the number further reduced to 1298. After applying the language criterion of including only English publications, this number reduced to 1272 (Figure 1).

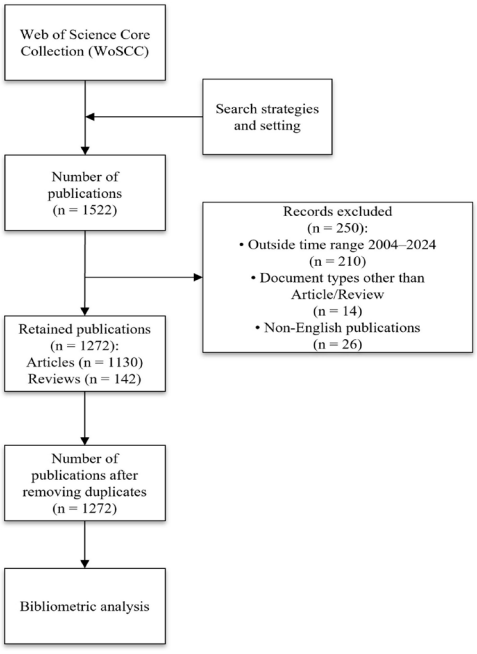

Figure 1. Flowchart for the search strategy and selection process of the bibliometric analysis

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VOSviewer (version 1.6.20), a widely accepted software in the field, was used for data visualization and network analysis [17]. VOSviewer provides advanced capabilities for creating and visualizing bibliometric networks, enabling the mapping of complex relationships between bibliometric data, including authors, countries, institutions, and keywords. Using this software, annual output, country productivity, co-authorship, citation patterns, and author keyword co-occurrence were assessed. For all networks, node size denotes production (publications or occurrences), edge thickness represents relational strength (links or total link strength), and color encodes cluster membership. For the overlay map, color instead reflects the average publication year, thereby visualizing temporal shifts in topic prominence.

The bibliometric analysis utilized in our study was derived from publicly accessible the open-access Web of Science database. As such, ethical committee approval was not required.

RESULTS

A total of 1272 studies examining the psychological status in TMD were identified. The annual publication count graph presented in Figure 2 reflects the psychological status in TMD and the increasing interest in this area between 2004 and 2024. Interest in the topic developed gradually during the first half of the twenty-year period analyzed (2004-2012). A clear turning point emerged in 2014, with the research area gaining acceleration. It was determined that the number of publications fluctuated over the last 10 years, peaking in the last two years. When evaluating the distribution of publications by country (Figure 3), the United States ranked first with 256 publications. The United States was followed by Brazil with 186 studies, Italy with 116 studies, and China with 99 studies.

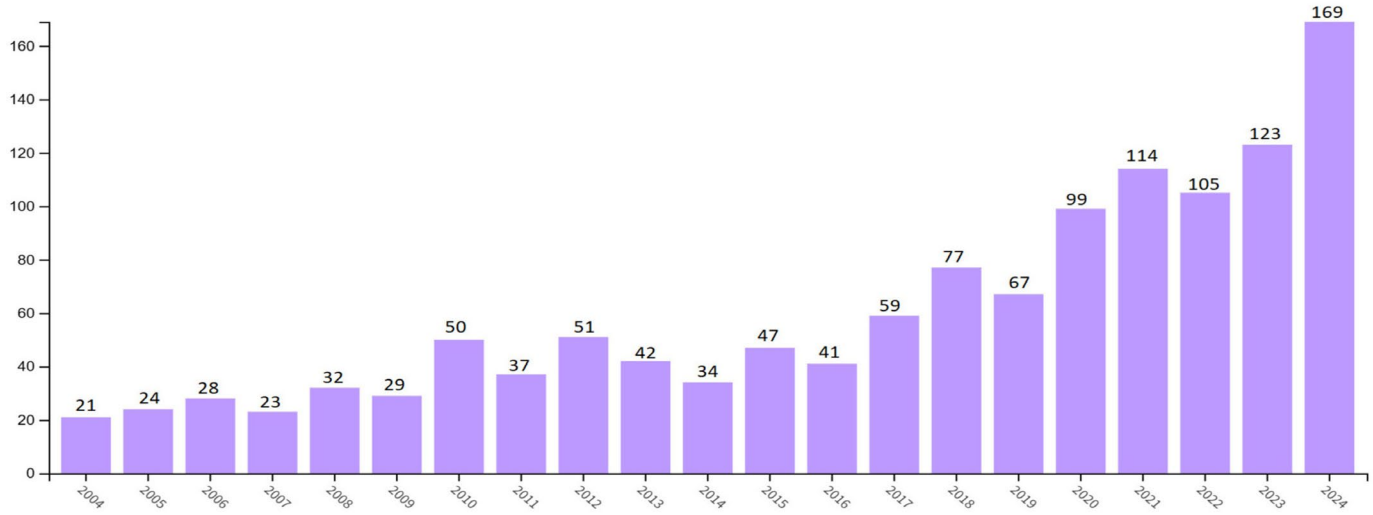

Figure 2. The annual number of publications (2004-2024)

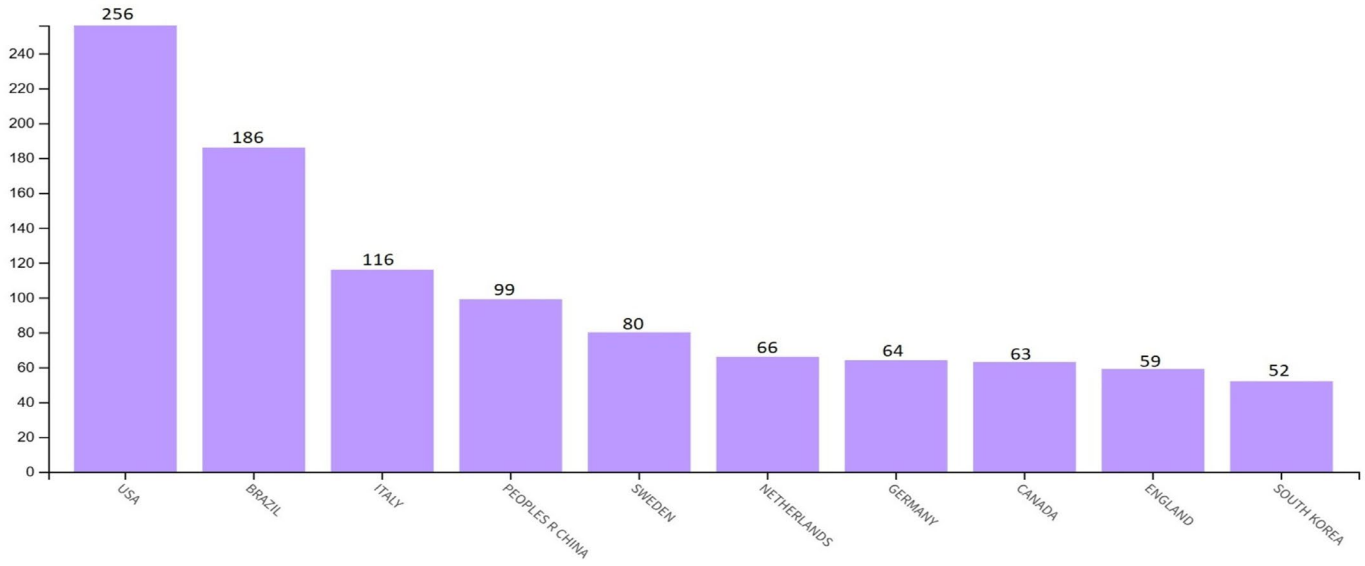

Figure 3. Top10 productive country

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Co-authorship of Authors

The analysis of author collaboration networks reveals the structure of scientific communities in a research field and the connections between key authors. The analysis performed with VOSviewer identifies the authors with the most collaboration and the highest total link strength, showing the authors at the center of research communities who direct the flow of information.

The analysis revealed that 4907 authors contributed to the psychological state in TMD. Among these authors, 112 authors were identified who had conducted at least five studies and whose studies had been cited at least 5 times. Upon examining the dataset, it was observed that names such as Ohrbach R. (40 links, 168 total link strength), Lobbezoo F. (33 links, 124 total link strength), and Svensson P. (36 links, 107 total link strength) were at the center of the network in terms of both the links number and the link strength. These authors stood out as the most productive and collaborative researchers in the field. Following them, others such as List T., Maixner W., and Michelotti A. also established a significant number of collaborative networks (Table 1).

Table 1. Top 10 most collaborative authors in the field

Authors	Links	Total Link Strength	Documents	Citations
Ohrbach R.	40	168	31	4136
Lobbezoo F.	33	124	40	4233
Svensson P.	36	107	29	3722
List T.	34	98	16	3609
Maixner W.	23	98	24	4825
Michelotti A.	33	94	14	3128
Rodrigues Conti P.	29	94	19	419
Fillingim R.	11	87	20	1652
Slade G.	11	87	18	1679
Visscher C.	31	85	22	3321

Upon visual examination of the collaboration map, the identified authors were divided into 10 distinct clusters (Figure 4). Distinct clusters, represented by different colors and concentrated around authors, were observed. The green cluster was seen to gather around Ohrbach R. and Maixner W. Similarly, the blue cluster gathered around authors such as Lobbezoo F., the orange cluster around Svensson P. and Visscher C., and the pink cluster around Michelotti A. The authors in the red cluster formed the largest cluster visible on the map, despite being unable to establish sufficient connections on their own. The co-author analysis revealed that the field has a highly linked structure, but it is clustered around several major clusters.

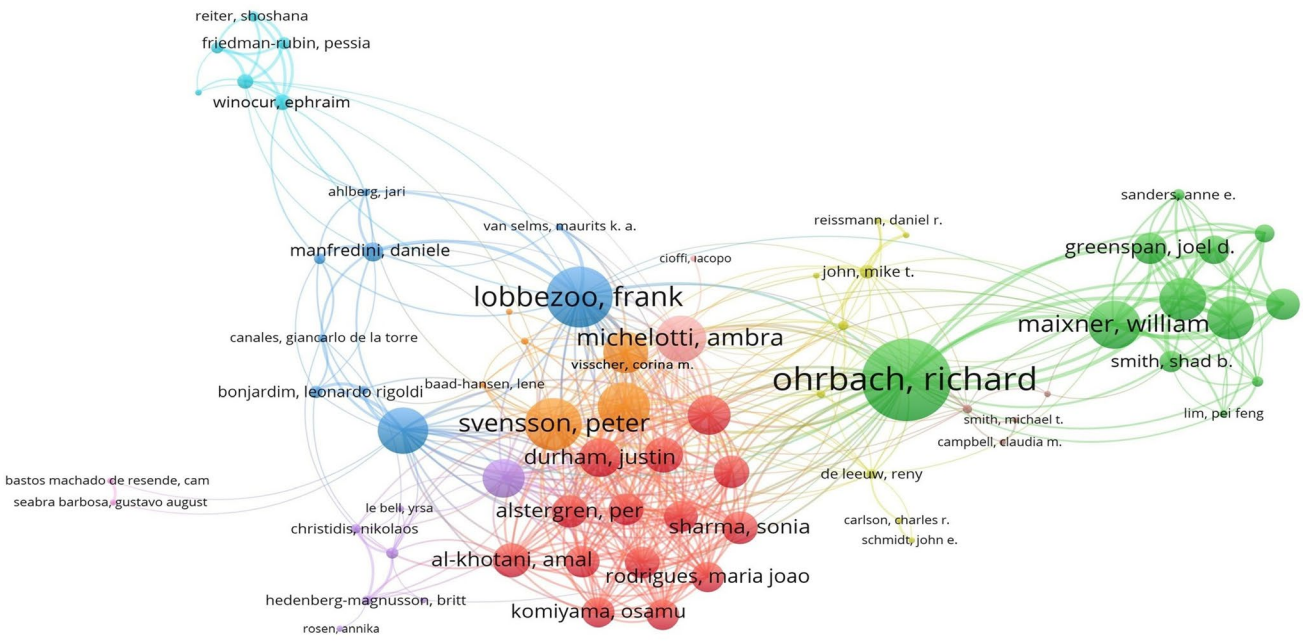

Figure 4. Collaboration network of productive authors

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Citations of Documents

Citation analysis of documents identifies the most influential and fundamental studies in a scientific field. This analysis highlights the documents with the highest number of citations, mapping important publications that form the theoretical basis of the field.

When examining these highly influential publications listed in Table 2, the most cited study in the field is the article "Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD)" published by Schiffman E. and colleagues in 2014 (2783 citations). Second on the list is the review titled "Bruxism physiology and pathology: an overview for clinicians" by Lavigne G. et al., published in 2008 (536 citations), and third is the publication titled "Painful Temporomandibular Disorder: Decade of Discovery from OPPERA Studies" (441 citations). These studies were followed by Turner J.'s "Mediators, moderators, and predictors of therapeutic change in cognitive-behavioral therapy for chronic pain" (389 citations) and Maixner W.'s publication titled "Overlapping Chronic Pain Conditions: Implications for Diagnosis and Classification" (377 citations).

Table 2. Top 10 most-cited documents in the field

Rank	Author	Title	Journal	Citations	Year
1	Schiffman E. [18]	Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) for Clinical and Research Applications: Recommendations of the International RDC/TMD Consortium Network and Orofacial Pain Special Interest Group	Journal of Oral & Facial Pain and Headache	2783	2014
2	Lavigne G. [19]	Bruxism physiology and pathology: an overview for clinicians	Journal of Oral Rehabilitation	536	2008
3	Slade G. [4]	Painful Temporomandibular Disorder: Decade of Discovery from OPPERA Studies	Journal of Dental Research	441	2016
4	Turner A. [28]	Mediators, moderators, and predictors of therapeutic change in cognitive-behavioral therapy for chronic pain	Pain	389	2007
5	Maixner W. [29]	Overlapping Chronic Pain Conditions: Implications for Diagnosis and Classification	Journal of Pain	377	2016
6	List T. [26]	Temporomandibular disorders: Old ideas and new concepts	Cephalalgia	361	2017
7	Manfredini D. [30]	Role of Psychosocial Factors in the Etiology of Bruxism	Journal of Orofacial Pain	340	2009
8	Kucyi A. [31]	Enhanced Medial Prefrontal-Default Mode Network Functional Connectivity in Chronic Pain and Its Association with Pain Rumination	Journal of Neuroscience	306	2014
9	Diatchenko L. [32]	Idiopathic pain disorders- Pathways of vulnerability	Pain	291	2006
10	Bueno C. [33]	Gender differences in temporomandibular disorders in adult populational studies: A systematic review and meta-analysis	Journal of Oral Rehabilitation	278	2018

Citations of Authors

Author citation analysis aims to identify the most influential authors in a research field, those frequently referenced in the literature. This analysis identifies authors with the highest number of citations and publications, highlighting the pioneers in the field and the magnitude of their contributions to the literature.

Among authors, 110 were identified who had published at least five papers and had had their papers cited at least five times. Upon examination of the dataset, the 110 authors who contributed the most were Ohrbach R. (with a total link strength of 1443), Lobbezoo F. (1404 total link strength), and Maixner W. (1052 total link strength). Following them were Yap U. (993 total link strength), Michelotti A. (976 total link strength), Visscher C. (968 total link strength), List T. (946 total link strength), Svensson P. (873 total link strength), Manfredini D. (796 total link strength), and Fillingim R. (675 total link strength) were also among the top 10 most influential authors in the field (Table 3).

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Table 3. Top 10 most-cited authors in the field

Authors	Links	Total Link Strength	Documents	Citations	Year
Ohrbach R.	102	1443	31	4136	2014
Lobbezoo F.	103	1404	40	4233	2008
Maixner W.	100	1052	24	4825	2016
Yap U.	75	993	33	310	2007
Michelotti A.	100	976	14	3128	2016
Visscher C.	99	968	22	3321	2017
List T.	100	946	16	3609	2009
Svensson P.	102	873	29	3722	2014
Manfredini D.	93	796	31	1457	2006
Fillingim R.	85	675	20	1652	2018

Upon examining the citation map, it was observed that these authors were positioned at the center of the network as large nodes, forming a dense citation network around them (Figure 5). In particular, the blue cluster, formed by Ohrbach R. and Maixner W., and the red cluster, including Lobbezoo F. and Michelotti A., emerged as the two main scientific centers in the field. Additionally, Yap A.U. (yellow cluster) and Manfredini D. (green cluster) also contributed to the field, although not as much as the other authors.

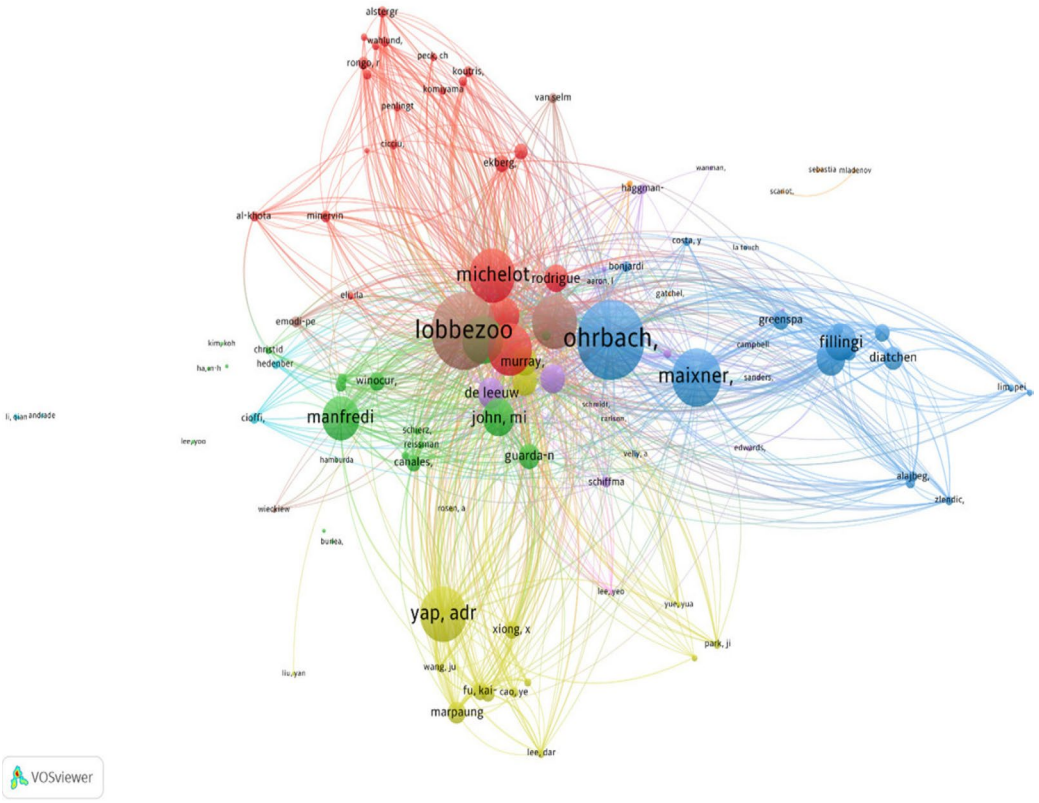

Figure 5. Visualization network of citation links of authors

Citations of Countries

The citation analysis of countries visualizes the global distribution of scientific production and the impact of countries in their respective research fields. This method identifies the countries with the most citations, revealing the centers of global knowledge production, the leading countries, and their respective contributions to the literature.

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In the analysis of countries, 76 countries contributed to the field on psychological state in TMD. 42 countries conducted at least five studies in the field, and these countries received more than five citations. According to the analysis results, the US was found to be the leader in this field with 14077 citations. It was followed by Italy (6224 citations) and Brazil (3899 citations). Countries such as Canada, Sweden, and the Netherlands ranked after these three countries (Table 4).

Table 4. Top 10 most-cited countries in the field

Countries	Links	Total Link Strength	Documents	Citations	Year
USA	41	4033	256	14077	2014
Italy	41	2835	116	6224	2008
Brazil	41	2413	186	3899	2016
Canada	41	2017	63	5629	2007
Sweden	41	1936	80	4964	2016
Netherlands	40	1906	66	4924	2017
England	41	1708	59	4852	2009
Germany	41	1674	64	4720	2014
China	41	1436	99	1313	2006
Denmark	40	1358	41	4233	2018

When examining the citation network map (Figure 6), it was observed that the US (blue cluster) was located at the center of the network and had strong connections with many other countries. Different countries, such as Italy, the Netherlands (red cluster), Canada (turquoise cluster), the UK, and Germany (green cluster), were seen to be clustered. This figure showed that the global flow of information in psychological state research in TMD is predominantly US-centered, but some European countries (Denmark, Sweden, Netherlands) also have strong connections in the networks.

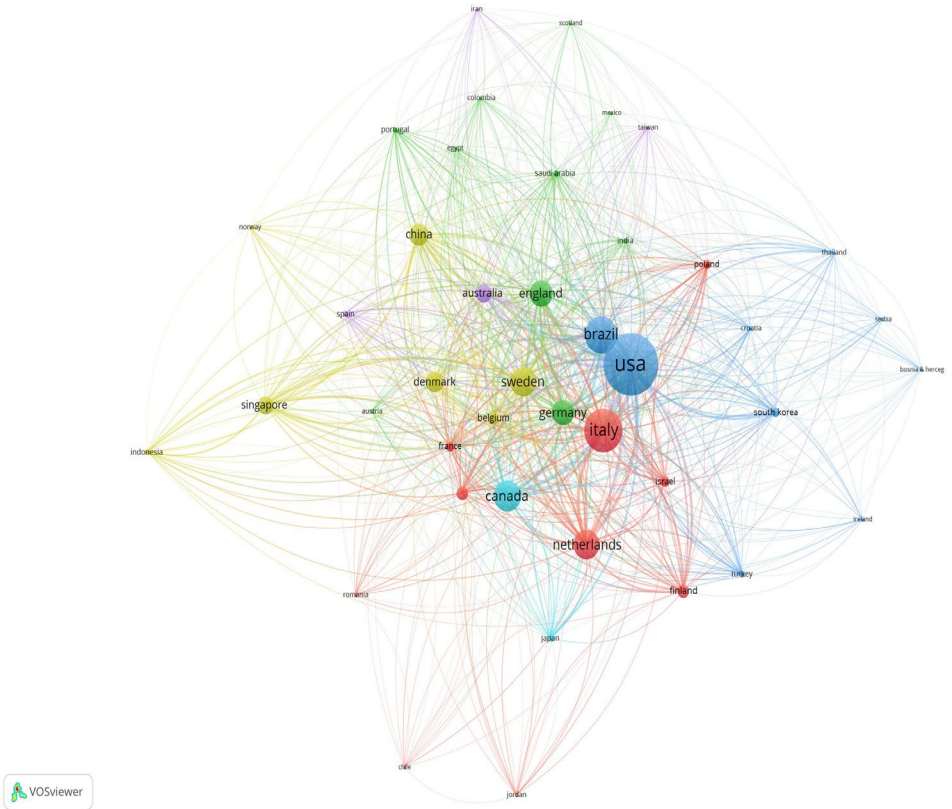

Figure 6. Visualization network of citation links of countries

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Co-occurrence of Author Keywords

The analysis of author keyword co-occurrence determines the conceptual map of a research field and its fundamental research themes. Based on the frequency with which keywords appear together in the same documents, this analysis visualizes the main topics in the field, emerging trends, and intersections between different research areas, revealing the thematic structure of the information.

The analysis identified 2102 keywords. Forty of these keywords were used at least 15 times in the studies. According to the analysis, terms such as temporomandibular disorders (1415 total link strength), depression (543 total link strength), anxiety (502 total link strength), orofacial pain (292 total link strength), and stress (263 total link strength) emerged as the most frequently used keywords. The average years in which these keywords were most prominent were identified (Table 5).

Table 5. Top 10 keywords by the number of co-occurrences

Keywords	Links	Total Link Strength	Occurrences	Average Publication Year	Year
Temporomandibular Disorders	90	1415	705	2018	2014
Depression	80	543	190	2017	2008
Anxiety	78	502	171	2018	2016
Orofacial pain	66	292	117	2017	2007
Stress	56	263	87	2020	2016
Pain	56	260	109	2017	2017
Bruxism	53	248	109	2019	2009
Chronic Pain	58	217	107	2017	2014
Temporomandibular Joint	48	150	69	2017	2006
Quality of Life	40	119	50	2019	2018

Cluster analysis of the keyword network revealed that the field consists of distinct color clusters representing related but different areas of expertise (Figure 7). The yellow cluster consisted of terms such as bruxism, myofascial pain, and masticatory muscles. The green cluster consisted of keywords such as chronic pain, orofacial pain, and headache, demonstrating the link between TMD and other chronic pain syndromes. Keywords such as anxiety, depression, quality of life, and stress formed the blue cluster. The red cluster consisted of keywords such as temporomandibular disorders, research diagnostic criteria, and epidemiology.

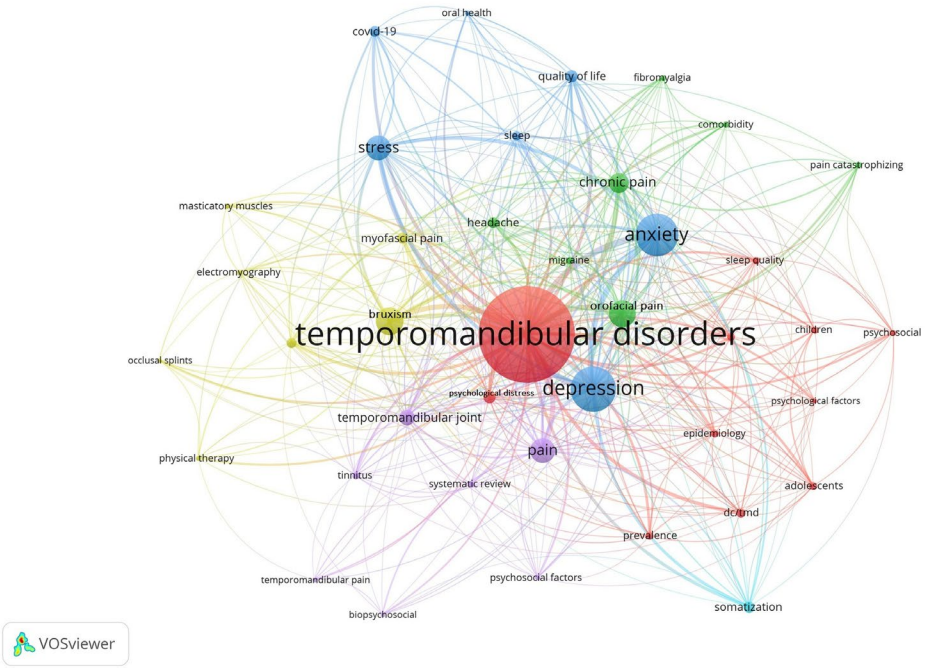

Figure 7. Visualization of the co-occurrence network of keywords

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The overlay visualization map (Figure 8) visualized keywords using color codes. The cooler colors, closer to blue on the map, represented older research trends, while the warmer colors, closer to yellow, represented more recent research trends. Upon examining the map, it was observed that the pioneering concepts forming the foundation of the field were keywords in blue and purple tones, such as DC/TMD, somatization, and epidemiology. It was found that keywords in green tones, representing the field's maturation period, such as chronic pain, headache, sleep, bruxism, and especially anxiety and depression, were located at the center. Keywords in yellow on the map, such as stress, COVID-19, and comorbidity, showed that the focus of studies changed over time.

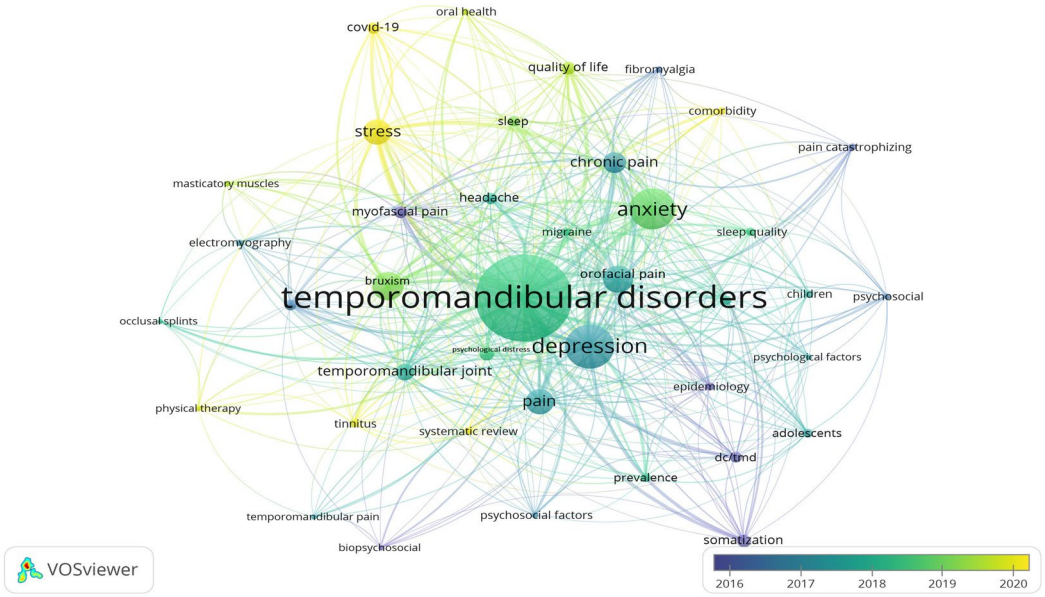

Figure 8. Visualization of keywords with timeline view

DISCUSSION

This bibliometric analysis presented the scientific map of the psychological state in TMD and its transformation between 2004 and 2024. Findings of our study revealed that this field has not only grown in volume but has also undergone a significant conceptual transformation. The field has shifted from traditional biomechanical and occlusal-focused approaches to a more holistic model that treats TMD as a complex psychological condition. Indeed, the fact that names such as Ohrbach R., Lobbezoo F., and Svensson P. were among the most productive and network-central authors in the field revealed that this transformation had been driven by specific authors. When examining the most cited publications that form the scientific backbone of the field, Schiffman et al.'s study ranked at the top [18], followed by Lavigne et al.'s review on bruxism [19] and Slade et al.'s OPPERA studies [4]. According to the author citation analysis results, the authors with the highest number of citations were Ohrbach, R., Lobbezoo, F., and Maixner, W., confirming the established structure of authors in the field. The quantitative leadership of the United States in the geographical distribution, closely followed by Italy and Brazil, demonstrated the global nature of this field. Keyword analysis revealed that the most frequently used keywords after the term"temporomandibular disorders" were depression, anxiety, orofacial pain and stress.

The consistent increase in the number of publications suggests that TMD is increasingly recognized as a significant public health concern and the increasing attention devoted to its psychological dimension. When examining the studies conducted by countries, the quantitative leadership of the USA in this field is consistent with other bibliometric analyses [14,20]. Italy, Brazil, and China follow the USA. However, when examining the citation network map of countries, the US leads in terms of productivity and citations, while European countries such as Italy, Canada, and Sweden have high citation rates despite producing fewer publications. On the other hand, Brazil has a relatively low impact despite its high production, and the same low impact applies to China. This multipolar structure indicates that knowledge is being researched on a global scale.

One of the most concrete and effective reflections of the conceptual transformation in the field is the change in diagnostic criteria. The Research Diagnostic Criteria for Temporomandibular Disorders, presented by Dworkin and LeResche in 1992, represented a significant first step toward an etiology-based classification system [21] However, over time, some limitations and inadequacies of this pioneering system, particularly in terms of validity and diagnostic accuracy in clinical practice, became apparent. At this point, the work of Schiffman, E., and Ohrbach, R., highlighted the weaknesses of the RDC/TMD and led to the development of a

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new evidence-based system. The study established international standards for the diagnosis and classification of TMD, resulting in the RDC/TMD system, which is suitable for both clinical and research purposes and has higher validity and reliability [18]. It has thus become the fundamental reference point in the field. Lavigne's article, "Bruxism physiology and pathology" provides clinicians with a comprehensive framework for understanding the pathophysiology of bruxism. Most subsequent studies have focused on pain mechanisms, psychosocial factors, and neurophysiological processes related to chronic pain. This demonstrates that the field is approached not only from a dental or temporomandibular joint perspective, but also through a multidisciplinary approach involving neurology, psychology, and pain science. From a bibliometric perspective, the most influential themes in the field revolve around the standardization of diagnostic criteria, understanding the mechanisms of bruxism and chronic pain, and examining psychosocial factors.

The fact that the most frequently used keywords after "temporomandibular disorders" in keyword analysis are "depression" and "anxiety" shows that psychological status is now part of TMD research. The prevalence of psychological disorders such as anxiety and depression in TMD patients is significantly higher than in the general population. This raises a frequently debated question in the field: Does psychological stress cause TMD, or do chronic pain and dysfunction cause these psychological conditions [22,23] Current evidence suggests that this relationship is not unidirectional but rather involves a reciprocal and cyclical interaction. Anxiety and depression can exacerbate existing TMD symptoms by lowering the pain threshold and disrupting pain modulation mechanisms, while the chronic pain, social isolation, and decline in quality of life associated with TMD also negatively affect an individual's mental health [7,8]. Therefore, the centralization of the keywords "depression" and "anxiety" in the keyword network serves as evidence for this bidirectional and complex relationship. Psychological and pain-related keywords such as depression, anxiety, orofacial pain, and stress indicate that psychosocial factors play an important role in the etiology and management of TMD and related pain disorders. Furthermore, the frequent repetition of concepts such as bruxism, chronic pain, and temporomandibular joint reflects that the studies encompass both biomechanical and neuropsychological dimensions.

Examining the change of keywords over time allows for an understanding of the distance the field has covered and the conceptual transformation it has undergone between 2004 and 2024. The overlay visualization map shows that in the early stages of the field, the focus was on fundamental and definitional concepts such as "myofascial pain", "diagnostic criteria TMD" and "epidemiology". However, over time, the shift in the map's colors toward warm tones, such as green and yellow, indicates a change in the research agenda. The centralization of concepts such as "chronic pain", "headache", "sleep" and "bruxism" indicates a phase in which the psychosocial model has taken hold, recognizing that TMD is not just a local problem but a complex syndrome intertwined with chronic pain, sleep disorders, and parafunctional habits [24,25]. Current concepts, such as "COVID-19", "quality of life" and "oral health" which are visible in the hottest yellow areas of the map, indicate the field's newest research areas and future potential. The emergence of the term "COVID-19" demonstrates the field's sensitivity to global health crises and that the effects of pandemic-related stress on TMD are being investigated. Similarly, the prominence of concepts such as oral health, quality of life, and stress indicates that the focus of research is shifting from symptom management to a more holistic approach centered on the patient's well-being and quality of life. This time-dependent change highlights the need for researchers and clinicians to shift their attention from the mechanical dimension of pain to the patient's emotional and psychological world, thereby shaping treatment approaches according to this holistic perspective [26,27].

CONCLUSION

In conclusion, this bibliometric study reveals that the literature addressing psychological status in TMD between 2004 and 2024 has undergone not only quantitative growth but also conceptual evolution. Findings suggest that TMD is shifting away from biomechanical and occlusal-based approaches and is being addressed within a multidisciplinary framework that also encompasses psychological processes. In particular, the centralization of the concepts of depression and anxiety in the keyword network shows that TMD is not just a local pathology but is closely related to the individual's psychological state, functionality, and quality of life. Approaches that center the biopsychosocial model in TMD research, which are holistic, patient-centered, and aimed at preventing pain-related disability, will shape future directions.

Conflict of Interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Ethical Approval
The bibliometric analysis utilized in our study was derived from publicly accessible the open-access Web of Science database. As such, obtaining approval from an ethics committee was deemed unnecessary.

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Original Article

Stab and sharp-penetrating injuries presented to a forensic medicine clinic: A five-year retrospective analysis

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Abstract

Aim: Sharp and sharp-penetrating injuries constitute an important group of trauma cases that require rapid, systematic, and objective evaluation in both forensic and clinical settings. This study aims to contribute to the regional literature by analyzing the demographic, clinical, and forensic characteristics of cases presenting to a forensic medicine outpatient clinic due to sharp and/or sharp-penetrating instrument injuries.

Materials and Methods: A total of 167 cases who presented to the Forensic Medicine Outpatient Clinic of Ordu University Training and Research Hospital between 2017 and 2022 were evaluated retrospectively. Demographic characteristics, injury patterns, etiological factors, and forensic classifications were analyzed. Multivariable logistic regression analysis was performed to identify factors associated with surgical intervention, and Poisson regression was used to assess annual trends.

Results: Of the cases, 83.2% were male, and the mean age was 33.3 years. Injuries occurred most frequently in the summer months, particularly in July, and Wednesday had the highest rate of presentations among the days of the week. The most common cause was interpersonal violence (75.4%), and knives constituted the vast majority of instruments used (98.5%). Under Articles 86–87 of the Turkish Penal Code, 37.1% of cases were classified as "requiring more than simple medical intervention." The surgical intervention rate was 13.2%. Multivariable analysis showed that penetrating thoracic injury (OR=27.9; 95% CI: 4.26–183.0; $p<0.001$) and muscle-tendon damage (OR=31.1; 95% CI: 6.52–148.7; $p<0.001$) significantly increased the likelihood of requiring surgery. Additionally, a statistically significant upward trend in annual case numbers was identified (IRR=1.34/year; 95% CI: 1.24–1.45; $p<0.001$).

Conclusion: Sharp-penetrating injuries were predominantly observed in young men and were mostly driven by interpersonal violence. The need for surgical intervention was primarily determined by anatomical depth and associated tissue damage. The increasing annual trend in case numbers highlights the necessity of closely monitoring regional violence dynamics and developing targeted preventive strategies.

Keywords: Sharp-penetrating injuries, interpersonal violence, forensic trauma

INTRODUCTION

Sharp and sharp-penetrating instrument injuries constitute a significant category of trauma cases that require specialized evaluation in both clinical and forensic settings. These injuries may occur as a result of interpersonal violence, criminal behavior, accidents, self-harm attempts, and various sociocultural conflicts [1,2]. The easy availability of sharp objects in daily life, particularly knives and glass materials, contributes to their frequent use in traumatic events and makes them a common cause of emergency department admissions [3–5].

In forensic medicine practice, the evaluation of such injuries involves not only clinical recovery but also the legal processes that follow. Determining the characteristics of the injury—including its anatomical location, depth, involvement of vital structures, and the need for medical or surgical intervention—requires an objective and systematic approach [2,4]. These features play

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a critical role in defining the forensic nature of the incident, classifying the potential offense, and preparing the medico-legal report. Therefore, a standardized and structured assessment is essential for both judicial authorities and healthcare systems.

National literature indicates that sharp and sharp-penetrating injuries constitute a consistent and significant portion of forensic cases across various regions of Türkiye [1,3–6]. Studies from different centers show that these injuries frequently affect young adults, that interpersonal conflicts are among the most common mechanisms, and that such cases represent an important issue for both public health and forensic law enforcement systems. International publications likewise report that sharp-force injuries represent a substantial proportion of both assault-related and self-inflicted harm, highlighting the need for multidisciplinary evaluation [7,8].

Obtaining regional data on sharp-penetrating injuries is important for identifying trauma distribution patterns and risk profiles, improving healthcare service planning, optimizing medico-legal reporting practices, and supporting violence-prevention strategies. Furthermore, data obtained from forensic medicine outpatient clinics offer field-specific insight, as they reflect the actual presentation profile encountered by both hospital and judicial systems. However, in the Black Sea Region, especially in studies focusing on outpatient-based sharp and sharp-penetrating trauma profiles, current research remains limited.

This study aims to retrospectively evaluate the demographic, clinical, and forensic characteristics of cases presenting to a forensic medicine outpatient clinic due to sharp and sharp-penetrating instrument injuries and to contribute to the existing literature.

MATERIAL AND METHOD

This study is based on a retrospective file review of cases presenting to the Forensic Medicine Outpatient Clinic of Ordu University Training and Research Hospital between 01.01.2017 and 31.12.2022 due to sharp and/or sharp-penetrating instrument injuries. Demographic data, incident characteristics, injury findings, and medico-legal reporting information were recorded. Cases with missing data and those whose trauma mechanism did not involve a sharp or sharp-penetrating instrument were excluded.

Data were analyzed using IBM SPSS Statistics for Windows, Version 22.0. Descriptive statistics were calculated, and categorical variables were evaluated using the Chi-Square test. A logistic regression model was employed for multivariable analyses. A p-value <0.05 was considered statistically significant. This study was approved by the Non-Interventional Clinical Research Ethics Committee of Ordu University (Date: 12.05.2023, Decision No: 142).

RESULTS

A total of 167 cases were evaluated, of which 83.2% were male (n=139) and 16.8% were female (n=28). The mean age of the victims was calculated as 33.34±13.52 years (minimum=6, maximum=72 years). When the monthly distribution of the cases was examined, the highest number of cases occurred in July (13.17%, n=22), while the lowest number was recorded in April (2.40%, n=4). Seasonal analysis showed that sharp-penetrating injuries were most frequently observed in the summer (35.33%, n=59), whereas the lowest number of cases occurred in the spring (16.77%, n=28) (Figure 1).

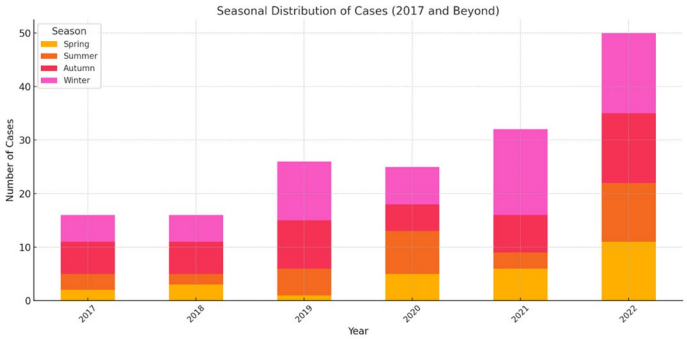

Figure 1. Seasonal distribution of sharp and sharp-penetrating injury cases by year (2017–2022)

The distribution by days of the week revealed that sharp-penetrating injuries occurred most commonly on Wednesdays (18.56%, n=31). The fewest cases were identified on Sundays (12.57%, n=21).

Of the cases, 75.4% (n=126) occurred as a result of assault. Other causes included occupational injuries (11.4%, n=19), self-harm (7.2%, n=12), accidents (5.4%, n=9), and suicide attempts (0.6%, n=1) (Figure 2).

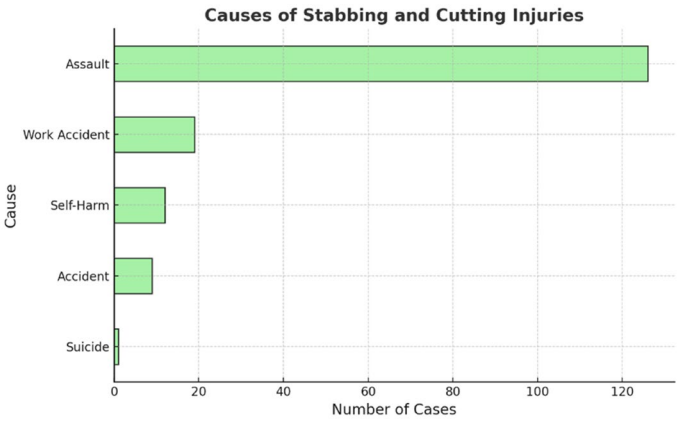

Figure 2. Distribution of causes of sharp and sharp-penetrating injury cases

In 80.24% of the cases (n=134), the injuries were caused by sharp-penetrating instruments, while 19.76% (n=33) were caused by sharp instruments. Among sharp-penetrating instruments, the most frequently used tool was a knife (98.5%, n=132), whereas among sharp instruments, glass objects were the most common (84.85%, n=28). According to Articles 86–87 of the Turkish Penal Code, 62.9% of the cases (n=105) were classified as "manageable with simple medical intervention," while 37.1%

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(n=62) were reported as "not manageable with simple medical intervention." Additionally, 88.6% of the injuries (n=148) were determined not to pose a life-threatening risk, whereas 11.4% (n=19) were considered life-threatening. Among the 167 cases, 13.2% (n=22) underwent surgical intervention. In the 24 cases requiring hospitalization, the mean length of stay was calculated as 5.25±3.21 days. Regarding penetration into body cavities, 6.6% of the cases (n=11) involved thoracic penetration, followed by abdominal penetration in 3.6% (n=6). Muscle or tendon injury was detected in 12.0% of the cases (n=20). A single wound was identified in 56.3% of the cases (n=94), whereas 33.5% (n=56) sustained between two and five wounds.

In 70.1% of the cases (n=117), the injuries were limited to a single anatomical region, whereas 29.9% (n=50) involved multiple regions. Among single-location injuries, the most frequently affected areas were the left hand (11.1%, n=13), right hand (9.4%, n=11), and left thigh (7.7%, n=9). In multi-region injuries, the left thigh (n=11), left hand (n=10), and left arm (n=9) were the most commonly involved sites. Knives were identified as the injuring instrument in 73.7% of the cases (n=123), while glass was responsible in 12.0% (n=20). The mean wound length was calculated as 2.95±2.67 cm, with a range of 0.1 to 25.0 cm.

Bivariate analyses revealed a strong association between life-threatening injury and the need for surgical intervention (χ^2=42.0, df=1, p<0.001). A significant relationship was also found between body-cavity penetration categories and surgery (χ^2=55.7, df=3, p<0.001). Surgical intervention rates were significantly higher in cases with muscle–tendon injury (χ^2=23.4, df=1, p<0.001). Instrument type distribution differed significantly by sex (χ^2=6.87, df=2, p=0.032); knife-related injuries were notably more common among males, whereas glass-related injuries were relatively more frequent among females.

In multivariable logistic regression, penetrating thoracic injury (OR=27.9; 95% CI: 4.26–183.0; p<0.001) and muscle–tendon injury (OR=31.1; 95% CI: 6.52–148.7; p<0.001) were identified as independent predictors of surgical intervention. Time-trend analysis demonstrated a significant increase in annual case numbers (IRR=1.34/year; 95% CI: 1.24–1.45; p<0.001).

DISCUSSION

In this study, the proportion of male cases was 83.2%, with a mean age of 33 years, paralleling previous research indicating that sharp-penetrating trauma predominantly affects men and is concentrated among young adults. In this regard, a study conducted in Manisa similarly reported that 94.5% of such cases were male and that most victims were between 20 and 39 years of age [9]. Likewise, Batbaş et al. found that 81.6% of fatal sharp-penetrating injuries occurred in men [10].

This pattern may be explained by increased social interaction and outdoor activities during the summer months, which can contribute to higher rates of violence. Indeed, another study from Manisa reported that medico-legal cases occurred most frequently during the summer, particularly in July [11]. The peak observed on Wednesdays in our dataset is a unique finding; further analyses are needed to determine whether this distribution is influenced by local social or environmental factors. For example, a study examining emergency department admissions in another region also identified Wednesday as the most frequent day for presentations, suggesting a possible association with mid-week social dynamics [12].

The finding that 75.4% of cases resulted from assault is consistent with reports from various regions of Türkiye, where interpersonal violence has been identified as the leading cause of sharp-penetrating injuries. Supporting this, Güloğlu et al. emphasized that the vast majority of sharp-penetrating trauma cases in Southeastern Anatolia were the result of interpersonal violence [13]. The exceptionally high proportion of knife-related injuries in our study (98.5%) aligns with international literature reporting knives as the most commonly used weapon in assault-related sharp-force trauma. For instance, an analysis of 1.315 penetrating injuries in Sweden between 1987 and 1994 found that knives constituted the primary weapon in the overwhelming majority of cases [14]. The relatively higher frequency of glass-related injuries among women is an important finding, suggesting a potential association with domestic accidents or environmental factors.

In this study, only 11.4% of cases were classified as life-threatening, which may be explained by the fact that outpatient forensic clinic admissions typically involve relatively less severe injuries. However, the rates of thoracic and abdominal penetration were consistent with those reported in the literature. Previous research has similarly indicated that sharp-penetrating injuries often involve vital regions such as the chest and abdomen. For example, Ambade and Godbole, in their study from India, found that the thorax was the most common site of injury among victims killed with sharp instruments [15]. The strong association between these injuries and the need for surgical intervention in our study is a notable finding. Supporting this, a study from Manisa reported that 40.8% of cases had injuries involving intrathoracic organs or major vessels, underscoring the potential severity of such trauma [9]. Additionally, in logistic regression analysis, penetrating thoracic injury (OR=27.9) and muscle–tendon damage (OR=31.1) emerged as the strongest predictors of surgical intervention. These results suggest that anatomical depth and the integrity of functional tissues are key criteria in determining the need for surgical consultation in clinical practice. The high magnitude of these associations also carries important implications for medico-legal reporting, particularly in assessing the severity of injury.

The Poisson time-trend analysis demonstrated a 34% annual increase in case numbers (IRR=1.34/year), indicating a marked rise in regional violence dynamics. National trauma epidemiology data likewise show an increase in interpersonal violence and sharp-penetrating injuries in recent years. For instance, judicial statistics indicate that the number of individuals convicted of

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violent offenses such as intentional injury in Türkiye increased from 17.222 in 2011 to 71.885 in 2020, a dramatic rise reflecting the substantial escalation of interpersonal violence over time [16]. This finding serves as a critical indicator for regional security policies, community-based violence prevention strategies, and planning of forensic healthcare services. Importantly, the observed annual increase in sharp and sharp-penetrating injury cases carries direct forensic implications, as it translates into a growing medico-legal reporting workload, increased demand for standardized injury assessment, and a greater need for resource planning within forensic medicine services.

The proportion of injuries classified as "not manageable with simple medical intervention" under Articles 86 and 87 of the Turkish Penal Code was 37.1% in our study. In a study conducted at Dicle University on medico-legal reports, approximately 48% of injuries were reported to be of a nature that could not be resolved with simple medical intervention [3].

CONCLUSION

Considering the limited availability of outpatient-based sharp-penetrating trauma data in the Black Sea Region, our study fills an important gap and provides a valuable regional reference dataset. The use of methods such as multivariable analysis and time-trend modeling further enhances the contribution of our findings to the literature.

This study identified the regional distribution, clinical severity, and key factors determining the need for surgical intervention in cases of sharp and sharp-penetrating injuries. Parameters such as thoracic penetration and muscle–tendon damage emerged as strong independent predictors of surgery, offering important guidance for both clinicians and judicial authorities. The increasing trend in case numbers over time highlights a dynamic that warrants close monitoring in terms of regional violence prevention and public health policy development.

Conflict of Interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Ethical Approval
This study was approved by the Ordu University Non-Interventional Research Ethics Committee, Türkiye (Date:12.05.2023, Decision No:142).

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Case Report

Isolated arteria vertebralis dissection resulting from gunshot bullet blast effect: Case report

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Abstract

Wound ballistics examines wounds resulting from penetration, permanent cavity, temporary cavity (blast effect), shock waves, primary and secondary fragmentations created by a firearm projectile. As injuries caused by the direct effect of the projectile, such as penetration and permanent cavity, temporary cavities and shock waves can also cause fatal injuries with their indirect effects. In our study, we aimed to discuss a case that was injured in the neck area with a gunshot bullet and had a life-threatening injury as a result of arteria vertebralis injury due to the blast effect of the bullet, in the light of the literature. It was reported that a 17-year-old female patient was injured by firearm projectile. It was sent to us by the judicial authority for the preparation of a forensic report. It is recorded that a filling defect was observed in the right arteria vertebralis. It was determined that the bullet did not directly damage the right arteria vertebralis. It was concluded that the filling defect occurred as a result of the dissection caused by the explosion effect of the firearm. Firearm injuries produces fatal consequences depending on the degree of injury to the tissue or organ compatible with its trajectory. As a result of the pressure effect created by the firearm projectile, injuries occur in the tissues due to the blast effect, also called temporary cavity. Although the blast effect is not due to the direct effect of the firearm projectile, such as penetration and permanent cavity, it causes injuries to adjacent tissues. While tissue damage resulting from blast impact is frequently described in intracranial and intrathoracic injuries in the literature, in our case, isolated arteria vertebralis dissection as a result of blast impact was presented as a rare condition.

Keywords: Blast impact, gunshot wound, forensic examination

INTRODUCTION

Wound ballistics examines the wounds caused by firearm projectile in tissues. Firearm projectile cause injuries in tissue due to penetration, permanent and temporary cavities, shock waves, and primary and secondary fragmentations [1-3].

The history of wound ballistics dates back to the 1830s. The real progress was made in the 1870s with Kocher's hydrodynamic theory of gunshot wounds. According to Kocher's hydrodynamic theory, pressure waves are formed due to the high explosive power of bullets and the displacement of liquids at high speed, and injuries may occur due to the effect of these pressure waves [4].

Just as injuries caused by the direct effect of the bullet, such as penetration and permanent cavity, temporary cavities and shock waves can also cause fatal injuries with their indirect effects [5-7]. In our study, we aimed to discuss a case that was injured in the neck area by a gunshot bullet and had a life-threatening injury as a result of arteria vertebralis injury due to the blast effect of the bullet, in the light of the literature.

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CASE

Our case is a 17-year-old female patient and was sent to us for a post-traumatic forensic report. In her medical history; It was learned that she was injured in her jaw by a gun that accidentally went off while she was sitting with her friends in the park. As a result of the examinations performed at the district hospital where she lived, a foreign body was detected in her neck, and she was referred to the university hospital of a nearby province. She underwent surgery due to a fracture in her jaw. The projectile could not be removed because it was close to the spinal cord. During the examination, it was observed that there was no difficulty in speaking, that she had difficulty eating solid foods, that there was no problem in swallowing, and that she occasionally had weakness in her arms and legs. She stated that she had to constantly use a blood thinning medication due to the injury to her vein.

The examination revealed that the gunshot bullet entry wound was on the mentum of the jaw, there was no exit hole, the incisors were missing on the right side of the lower jaw, the mouth opening was full and jaw movements were free in all directions, and the muscle strength of the left forearm and hand was reduced by 1 in 5. was seen. In cervical CT examination; Metallic density of a gunshot bullet was observed adjacent to the right peduncle of the C4 vertebra, and there was no radiopathology in the brain CT examination. When bilateral carotid artery CT Angiography was examined by us; In the right vertebral artery injection, it was observed that the right vertebral artery was filled up to the C4 vertebra level and there was a filling defect in its distal part. In the left vertebral artery injection, the right vertebral artery showed retrograde filling over the basilar artery up to the level of the metallic body, and the findings were evaluated in favor of right vertebral artery dissection (Figure 1). In the neurological examination; It was observed that dysesthesia in the lower jaw, hypoesthesia on the outer part of the left shoulder, left shoulder abduction was -5/5, the left arm fell prematurely in the paresis test, and the brain CT examination was normal. MRI could not be performed due to the metallic object. Although the brain CT scan was normal, the numbness and weakness in his left arm were considered as sequelae.

In conclusion; Since the person had a right arteria vertebralis injury, it was concluded that the person's injury created a situation that endangered his life.

Figure 1. Right artery vertebralis filling defect in the left artery vertebralis injection

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DISCUSSION

The main working principle of firearms, which entered the lives of human beings with the invention of gunpowder and are used to meet basic needs such as protection and nutrition, is to send the bullet in the gun as far and as quickly as possible through the air with the gas pressure created by the combustion of gunpowder [1].

With the development of firearms, especially in the last centuries, and the extreme increase in their use since the 19th century, studies to examine the weapon, the projectile, and the effects of the projectile on the target organ have also increased. The branch of science that carries out these studies is ballistics [8-10]. Ballistics can basically be divided into three groups. İnternal ballistics examine the firing of bullet, external ballistic examine the flight of projectile and terminal ballistics examine of the changes caused projectile on the target. Wound ballistics is a part of terminal ballistics and examines the effects of firearm projectiles on the human or animal body [2,4,6,11]. A projectile entering the body progresses by disrupting and displacing tissues and produces fatal consequences depending on the degree of injury it causes in the tissue or organ compatible with the trajectory [11,12].

Firearm projectiles cause injuries in tissues and organs through penetration, permanent cavity, temporary cavity, shock waves and fragmentation [2,13,14]. While penetration, permanent cavity and primary fragmentation occur due to the direct effect of the bullet, temporary cavity (blast effect), shock waves and secondary fragmentation (injuries caused by bone fragments) are among the indirect effects of the bullet.

Figures 2 shows the permanent and temporary (blast effect) cavity and shock wave formation created by the projectile.

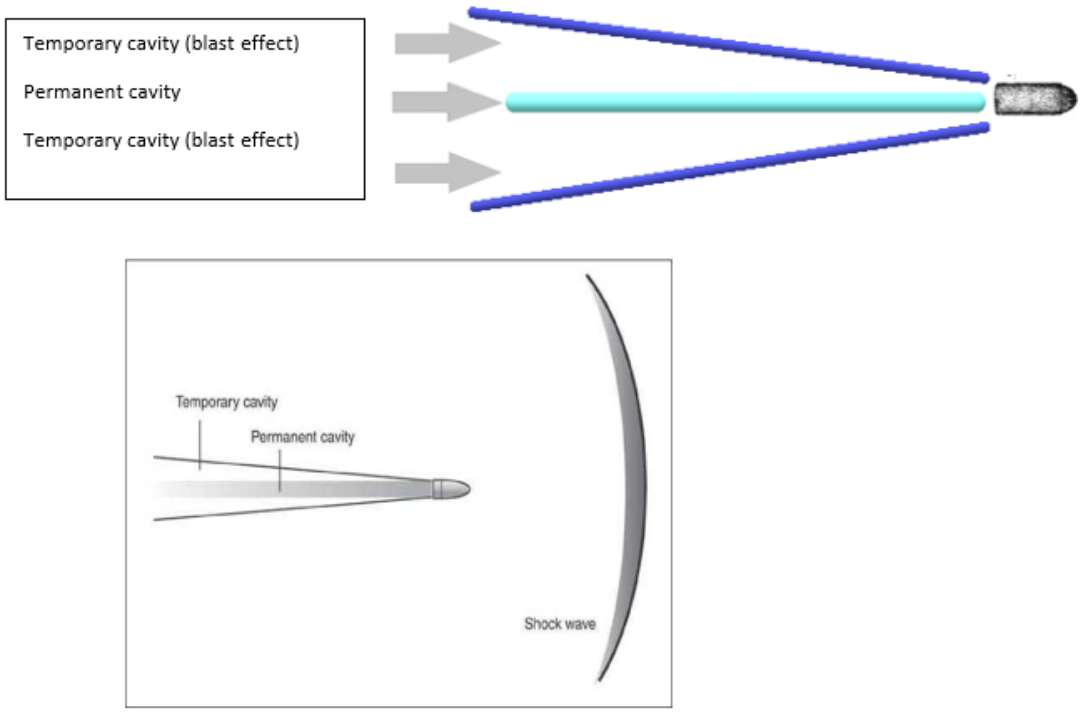

Figure 2. Effects of firearm projectile on tissue

Temporary cavity (blast effect) is the injury that occurs in the tissues due to the pressure effect created by the projectile [15-17]. The blast effect is greater in bullets with high kinetic energy, and most of the energy of these bullets is spent creating temporary cavities. Bullets with high kinetic energy begin to tumble after a while after entering the tissue, and during this movement, the kinetic energy transferred to the tissue and, accordingly, the diameter of the temporary cavity increases [18]. In structures with low tissue thickness, such as the extremities, the temporary cavity is smaller as the bullet leaves the body before it begins to tumble. Injuries due to blast impact are more common in the abdominal and chest cavities due to their large diameter [19]. Due to the blast effect, injury may also occur in parenchymal organs such as the liver, kidney and spleen [20].

Injuries due to blast effects are less common in organs with more elastic tissue, such as the lungs, because they tolerate the tension caused by pressure waves better. Very serious injuries may occur due to the blast effect in tissues with little or no elastic tissue, such as the liver and brain [8]. Injury and temporary displacement occurring in tissues such as skeletal muscle, vessels and nerves due to the temporary cavity appear like blunt trauma [6]. In some studies, it has been reported that the blast effect even causes bone fractures, although rarely [6,21,22].

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Due to the high conductivity of fluids, blood transmits pressure waves more than parenchymal tissues, and for this reason, injuries due to blast effect in main vascular structures may be more common [2]. In the literature review, although various injuries occur in the body due to blast impact, it is presented that there is no isolated arteria vertebralis injury.

CONCLUSION

Blast effect can also indirectly pose a danger to life. In gunshot wounds, secondary injuries that may be caused by the blast effect and shock wave-related energy, as well as the primary injuries that occur in the tragedy, should not be ignored. Injuries due to blast impact are important to prevent incomplete evaluations that may arise during forensic report preparation and to evaluate fatal and non-lethal injuries during forensic autopsy.

Conflict of Interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
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Patient Informed Consent
Informed consent was obtained from the relative of the deceased.

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Letter to the Editor

Urgent call for the initiation of support for forensic medical activities in the Gaza Strip

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Dear Editor,

The Gaza Strip has been under blockade since 2007, resulting in significant deprivation of resources for its inhabitants [1]. On October 7, 2023, Hamas fighters attacked a music festival in Israel and took several audience members hostage [2,3]. In response, Israel declared war on the Gaza Strip, intensifying the conflict. This ongoing conflict, compounded by the longstanding blockade, has severely impacted forensic medicine in Gaza, prompting me to write this letter to Novel Forensic Research.

While global attention is focused on the urgent needs for food, energy, and healthcare in Gaza, with approximately 35,000 civilian deaths reported, primarily among women and children, it is equally crucial to address the human rights violations occurring there [4]. The Fourth Geneva Convention mandates the International Committee of the Red Cross (ICRC) to protect civilians in wartime, investigate human rights abuses, identify perpetrators, and bring charges. On May 20, 2024, the International Criminal Court issued a statement regarding the prosecution of officials allegedly involved in war crimes related to this conflict. Subsequently, at its 56th session in Geneva from June 18 to July 12, 2024, the ICRC published a report on human rights violations and provided recommendations [4-8]. Despite these reports, forensic medical activities in Gaza remain inadequate and delayed due to the challenging conditions [9].

The ICRC is mandated to offer substantial support in forensic science, including tools, facilities, and organizational assistance. However, statements from ICRC officials confirm that the region's conditions are not conducive to such support [10-12]. The Palestinian forensic medicine system and crime scene investigations, already chaotic and incomplete before the conflict [13-16], now face an unprecedented crisis, with only two forensic specialists handling tens of thousands of bodies [17].

Historical lessons from the Gaza conflicts of 2014 and the Srebrenica massacre of 1995 emphasize the need to continue forensic investigations, including those concerning physical, sexual, and psychological abuse [18-22]. Efficient and timely autopsies, conducted under proper conditions, are critical. As evidence in war crimes cases is at risk of loss, ensuring its security and protection is essential [23]. Establishing teams of international volunteers—comprising forensic specialists, anthropologists, pathologists, archaeologists, and geneticists—is vital for thorough investigations and to address issues of missed bodies or unresolved war crime allegations [22,24,25]. Furthermore, ongoing DNA-based disaster victim identification efforts are crucial for finding relatives of the deceased. Ensuring the safe transfer of autopsy samples (histopathological, toxicological, and biological) to laboratories in countries like Egypt through the Rafah border gate is also recommended for comprehensive analysis [26-28].

In conclusion, the dire situation despite ceasefire in Gaza necessitates urgent international forensic medical support [29]. While humanitarian aid addresses immediate needs, the

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systematic investigation of potential war crimes and human rights abuses demands robust forensic infrastructure. The current system, overwhelmed and under-resourced, struggles to process the sheer volume of casualties, jeopardizing crucial evidence. International collaboration, through volunteer teams of forensic specialists and facilitated transfer of samples for analysis, is essential to ensure thorough investigations, accurate identification of victims, and the preservation of evidence vital for pursuing justice and accountability. This support is not merely a matter of professional duty but a moral imperative to uphold human rights and provide closure to grieving families amidst this devastating conflict. Expectation from the global forensic community to advocate for enhanced resources and protection for forensic professionals operating in conflict zones to ensure accountability and uphold human rights.

Conflict of Interests

The authors declare that there is no conflict of interest in the study.

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