Observational Study

Medicine

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Global hotspots and trends in Myofascial Pain Syndrome research from 1956 to 2022

A bibliometric analysis

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Abstract

Myofascial Pain Syndrome (MPS) is a prevalent disease, and the related literature research has been increasing in recent years. However, there is a lack of scientific and comprehensive bibliometric analyses in the MPS research field. This study aimed to summarize and visualize the literature distribution laws, research hotspots and development trends in MPS based on bibliometric methods. Relevant literature on MPS research from 1956 to 2022 was retrieved from the Web of Science Core Collection database. Quantitative and visual analyses of the collected literature were performed using Microsoft Office 2021, Bibliometrics, VOSviewer, and CiteSpace. A total of 1099 papers were included, and the number of papers in this research field is generally upward. The USA has the most publications (270), and Univ Sao Paulo is the institution with the most publications (31). Hong CZ and Calvo-Lobo C have the same number of publications and are the authors with the most publications (20), and Simons DG is the author with the most co-citations (1078). *Journal of Musculoskeletal Pain* is the journal with the most publications (61), and *Pain* is the journal with the most co-cited papers (2598) and the highest impact factor (7.926). *Lidocaine injection versus dry needling to myofascial trigger point. The importance of the local twitch response* is the reference with the highest number of co-citations (136). The top 5 keywords in this period are myofascial pain syndrome (571), trigger points (218), pain (97), myofascial pain (92), and myofascial trigger point (80). The keywords of recent bursts are dry needling (2016–2022), efficacy (2020–2022), validity (2020–2022), temporomandibular joint disorder (2020–2022), and orofacial pain (2020–2022). This study summarizes and visualizes the evolution, research hotspots, and future trends of the global MPS domain from 1956 to 2022. It is helpful for scholars to understand the general situation of MPS research quickly and provide a reference for clinical decision-making and future research directions.

Abbreviations: MMPS = masticatory myofascial pain syndrome, MPS = Myofascial Pain Syndrome, MTrP = Myofascial Trigger Points, TMD = temporomandibular joint disorder, WOSCC = Web of Science Core Collection.

Keywords: bibliometric analysis, CiteSpace, myofascial pain syndrome, trigger points, visualization

1. Introduction

Myofascial Pain Syndrome (MPS) is a musculoskeletal disorder with sensory, motor, and autonomic symptoms caused by a localized tension area consisting of skeletal muscle and fascia.[1] This area is called Myofascial Trigger Points (MTrP), which can cause pain-based clinical symptoms.[2] Approximately 30.0% to 93.0% of patients with musculoskeletal pain had MPS, and about 46.1% had active MTrP on physical examination.[3] In recent years, the pathological mechanisms, diagnostic strategies, and therapeutic measures of MPS have received increasing attention. However, researchers around the world have not yet reached a consensus on the etiology and pathogenesis of MPS, and there is no unified diagnosis and treatment standard.[4] "Myofascial pain" was first publicly described by Travell et al in 1952.[5] Sola and RL[6] proposed the concept of "MPS" in 1956 and pointed out that it is a disease with high incidence, complex treatment, and little known. In recent years, the number of papers about MPS has gradually increased, making it hard for scholars to quickly get the critical issues and hot topics in the domain of MPS research. Bibliometric analysis has emerged as an excellent means for quantitatively studying academic literature within a given area using a method. Being able to quickly gain a deep understanding of the research hotspots and evolution trends provides people with valuable information on the progress of relevant disciplines, which is helpful for evidence-based clinical decision-making. To our knowledge, no scientifically comprehensive quantitative analysis of the MPS study exists. To fill this gap, we executed a bibliometric analysis to qualitatively and quantitatively discuss MPS studies published from 1956 to 2022. The primary purpose of this study is to summarize the main research clusters, provide the current situation of the

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The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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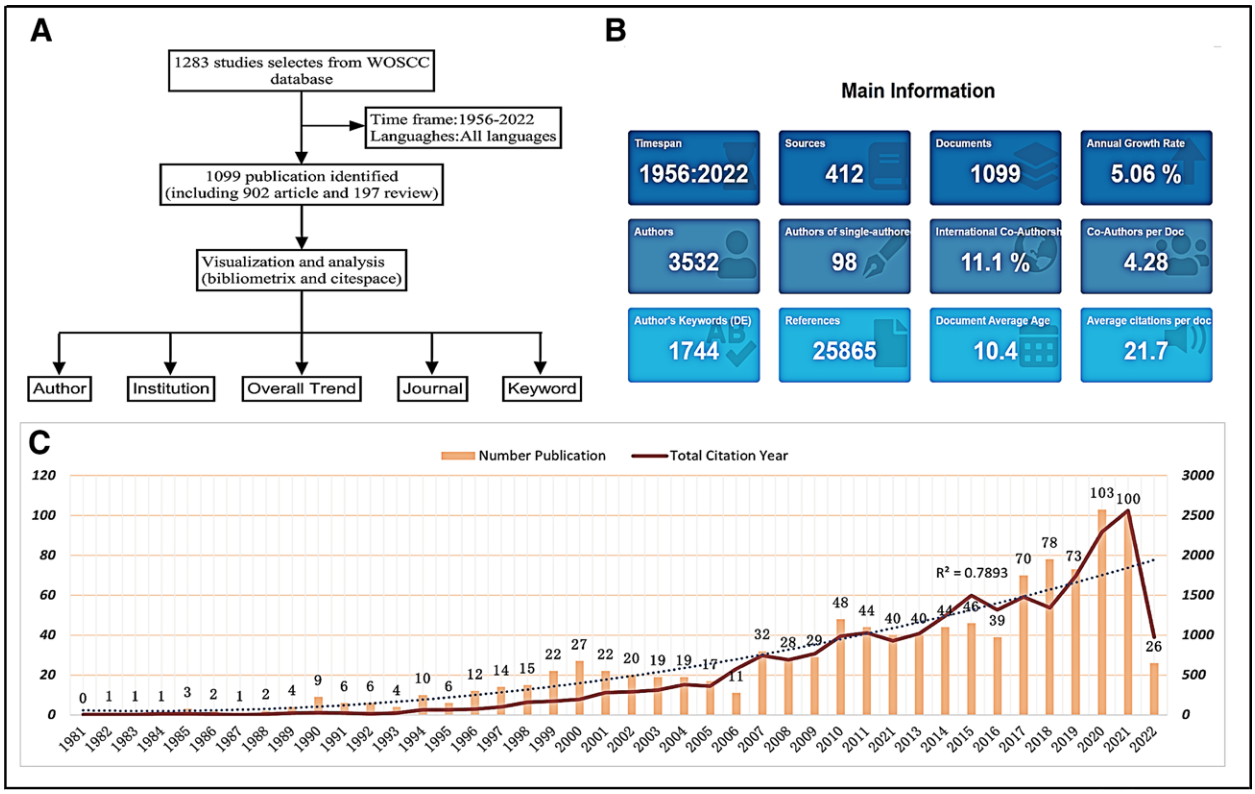


Figure 1. (A) Research flow chart. (B) Main information involved in MPS. (C) General trends in publications and citations 1981 to 2022. The left vertical axis represents the annual number of publications, and the right vertical axis represents the annual total citations. The dotted line in the figure is the trend line for the number of publications. MPS = Myofascial Pain Syndromes.

MPS field and general research directions, and present prospects for the future evolution of this field.

2. Methods

2.1. Data source

This bibliometric analysis is based on the Web of Science Core Collection (WOSCC), which is acknowledged as the most suitable database for performing bibliometric analyses. All data were collected on June 30, 2022, by searching the WOSCC for the literature published from 1956 to 2022, with no language restrictions. Search: TS=("Myofascial Pain Syndrome" OR "Myofascial Pain Syndromes" OR "Pain Syndrome, Myofascial" OR "Pain Syndromes, Myofascial" OR "Syndrome, Myofascial Pain" OR "Trigger Point Pain, Myofascial" OR "Myofascial Trigger Point Pain" OR "Syndromes, Myofascial Pain") and Article or Review Articles (Paper Types). Since all raw data used in this study were obtained from a public database, no ethical review was required.

In total, 1099 papers were included in the study and records were exported as "plain text files." The record's content is "full records and cited references," saved in "download_txt" format. Two authors sorted out the extracted data independently. If there were any differences, the third author would join the discussion and reach a consensus.

2.2. Data analysis

CiteSpace, VOSviewer, Microsoft Excel 2021, and Bibliometrics (R-Tool of R-Studio) were used for quantitative and visual analysis.

The Bibliometrics (R-Tool of R-Studio) was used for comprehensive scientific cartographic analysis and combined with Biblioshiny to export and organize data from WoSCC. The essential data include author name, journal source, issue count, country, keywords, and citation count.

VOSviewer is software for making and viewing bibliometric maps. It can be used to construct country or author maps based on collaborative data and make keyword networks or reference maps based on co-occurrence data.

CiteSpace focuses on analyzing the fundamental knowledge of scientific literature and is a visual analysis tool that gradually extended in data visualization and scientometrics. CiteSpace is used for network analysis of institutions and authors and burst detection of references and keywords.

Because all primary data used in this study were obtained from public databases, there is no need for an ethical review.

3. Results

3.1. Overall publication performance

The general flow of the study is shown in Figure 1A and B displays the primary information of the study. The annual number of publications and literature citations reflect the research trend and influence of the field, respectively. From 1956 to 1980, we all retrieved 5 publications on MPS research. Figure 1C shows the annual publications and annual total citations of MPS research from 1981 to 2022, which are on the rise in general. The number of publications was relatively small before 1996 and gradually increased in 1996 and after, reaching a peak in 2020 (n = 103). Total citations vary with publications, peaking in 2021.

3.2. Analysis of countries and regions

According to statistics, 1099 papers were published in 57 countries or regions from 1956 to 2022. The countries and regions with the top 10 publications are presented in Table 1. The country with the most publications is the USA (n = 270),

followed by Turkey (n = 120) and Spain (n = 97). Figure 2A is a network cooperation map of countries. The figure shows that the USA has strong cooperative relations with Spain and Brazil. In Figure 2B, the number of single-country and total publications is the largest in the USA, and the number of collaborative publications in multiple countries is the largest in Brazil.

3.3. Analysis of institutions

Figure 2D shows the cooperation relationship between institutions. The larger the circle represents, the higher the "Degree" of the institution, indicating that it is more critical in the network diagram. Sao Paulo University, University of Toronto, Coruna University, Lyon University, and Istanbul University are the most critical in the network diagram. The lines between the circles represent the cooperative relationship between the institutions, and the thicker the lines, the closer the cooperative relationship. The top 14 most prolific institutions are shown in Figure 2C; Univ Sao Paulo (Brazil, 31 publications) has the most publications, followed by Istanbul Univ (Turkey, 19 publications) and Univ Toronto (Canada,18 publications).

3.4. Analysis of authors

In total, 3532 authors were involved in the MPS study, with an average number of authors per paper of 3.2. The top 10

Table 1

Top 10 countries based on the total number of publications for 1956 to 2022.

Rank	Country	Year	Centrality	Count (%)
1	USA	1973	0.62	270 (24.57)
2	Turkey	1999	0.01	120 (10.92)
3	Spain	2001	0.28	97 (8.83)
4	Brazil	1994	0.05	80 (7.28)
5	South Korea	2005	0.00	64 (5.82)
6	Germany	1991	0.03	56 (5.10)
7	Taiwan	1996	0.01	56 (5.10)
8	Canada	1977	0.06	54 (4.91)
9	Italy	1991	0.05	48 (4.37)
10	China	2007	0.08	48 (4.37)

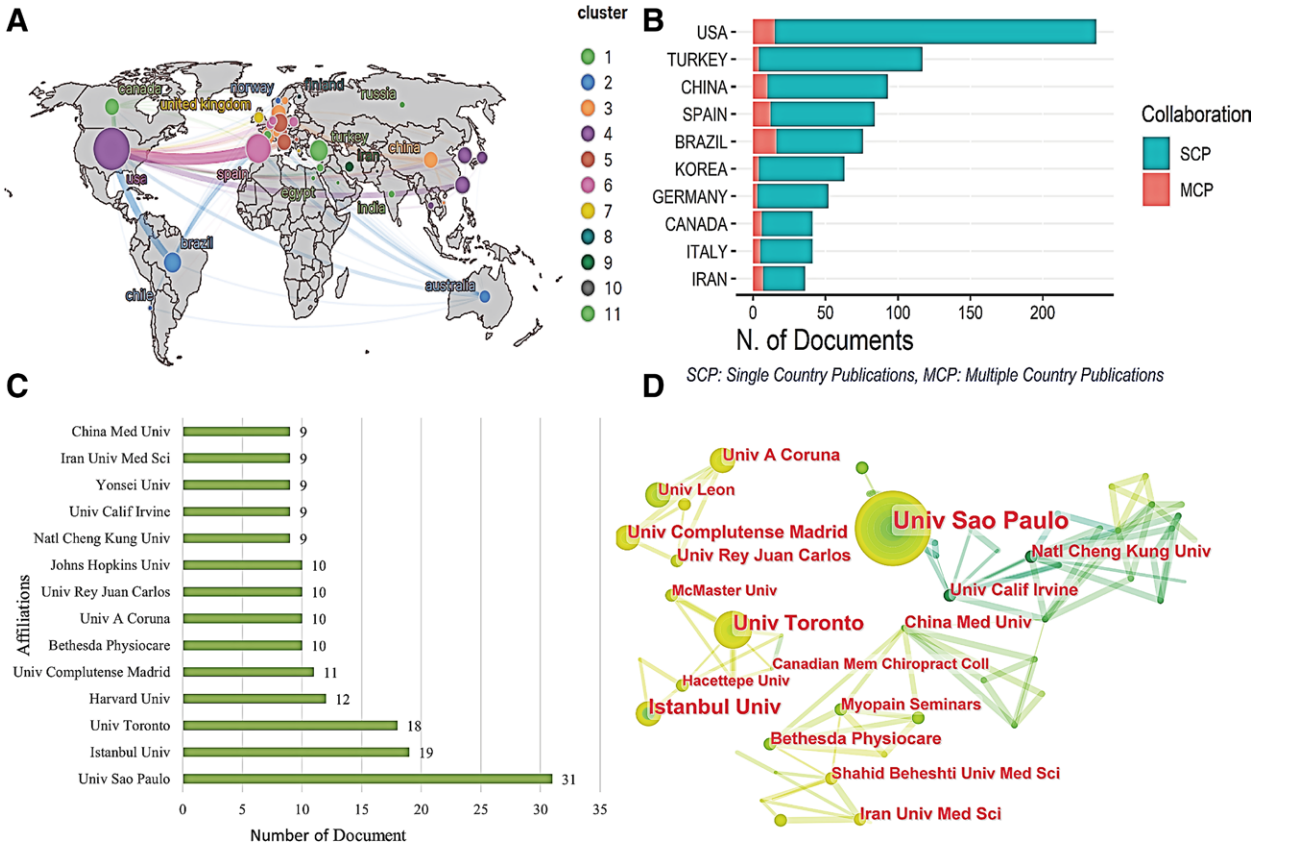


Figure 2. (A) World Collaborative Relationships Map. Each node in the figure represents 1 country, and the node size positively relates to the number of publications, and the line between nodes represents the cooperative relationship. The thicker the line, the closer the relationship. (B) Comparison of single-country publications and multiple country publications from different countries. (C) Top 14 most productive institutions between 1956 and 2022. (D) The co-authorship network visualization map of institutions for MPS research. Each node in the figure represents 1 institution, and the larger the circle represents, the higher the "Degree" of the institution. The lines between the circles represent the cooperative relationship between the institutions, and the thicker the lines, the closer the cooperative relationship. MCP = multiple country publications, SCP = single-country publications.

authors participating in this research are shown on the left side of Table 2. Hong CZ and Calvo-Lobo C are the most prolific authors; both published 20 papers. However, Hong CZ's citation frequency is 1981, while Calvo-Lobo C's is 196. As shown in Figure 3A, the publication years of Hong CZ are concentrated in 1993 to 2015, and the publication years of Calvo-Lobo C are mainly concentrated in 2017 and later. As shown in Figure 3B, the H-index of Hong CZ's papers reached 19, which was significantly higher than that of other authors. The higher the H-index, the greater the influence of the paper. As displayed in Figure 3C, CiteSpace visualizes the network between authors and collaborations. It can be seen that there are many independent networks in the figure. The co-cited authors are authors cited by another document or documents simultaneously, and these authors constitute a co-citation relationship. The degree of citation is an essential indicator for measuring authors' contributions. The right side of Table 2 shows the top 10 co-cited authors, with 1 author having been co-cited more than 1000 times. The author, Simons DG, was co-citations the most, 1078 times. Figure 3D shows a VOSviewer-based network graph, showing 50 authors with over 60 co-citations. On the mapping, Simons DG is the most prominent author.

3.5. Analysis of journals

VOSviewer software was used to analyze the published literature in the journal visually, and the summary is shown in Table 3. *Journal of Musculoskeletal Pain* (n = 61, 5.56%) had the largest published papers, followed by the *Archives of Physical Medicine and Rehabilitation* (n = 47, 4.27%). Among the top 10 journals, *Pain* (7.926 points) had the highest impact factor. Two of the top 10 cited co-cited journals have more than 1000 citations. *Pain* had the highest number of co-citations (n = 2598), followed by the *Archives of Physical Medicine and Rehabilitation* (n = 1816). The more co-citations a journal has, the more influential the journal is. The double map of journals shows the citing journals on the left, representing where the retrieved records publish, and the cited journals on the right. Colored paths represent the cited relationship between journals. The pink path in Figure 4A shows that the literature published in the disciplines of Molecular/Biology/Genetics, Health/Nursing/Medicine, Sports/Rehabilitation/Sports and Psychology/Education/Society are frequently cited in Neurology/Sports/Ophthalmology.

3.6. Analysis of references

A co-cited reference is when two or more papers appear in the reference list of other papers simultaneously, reflecting the citation relationship between the papers. Out of 1099 papers, 25,825 co-cited references were identified. The top 10 most cited literature are displayed in Table 4. *Lidocaine injection versus dry needling to myofascial trigger point: The importance of the local twitch response* had the highest number of co-citations (n = 136).[7] As shown in Figure 4B, This paper was the most influential among the networks co-cited in the papers, with strong connections with other papers. The citation bursts reflect the references that researchers are interested in at a given time. CiteSpace is used to identify references with the most robust citation burst. Figure 4D displays that the burst values of the first 22 works of literature with the most powerful reference burst fluctuate between 8.08 and 17.14. "Shah JP, 2005, J APPL PHYSIOL, V99, P1977" has the strongest citation burst (17.14).[8] The burst of 13 works of literature lasted as long as 5 years. A total of 2 papers had the most recent burst, "Cerezo-tellez E, 2016, PAIN MED, V17, P2369" and "Fernandez-laspenas C, 2018, PAIN MED, V19, P142."[9,10]

3.7. Analysis of keywords

In total, extracting 1737 keywords from 1099 papers, the number of occurrences was limited to 10 or more, so 54 keywords were identified. The top 5 keywords were MPS (n = 571), trigger points (n = 218), pain (n = 97), myofascial pain (n = 92), and myofascial trigger point (n = 80). Figure 4C shows the keyword co-occurrence network with keywords grouped into 4 clusters. Cluster 1 (red) involves the clinical features and treatment-related contents of MPS, such as trigger points, pain, rehabilitation, botulinum toxin, and chiropractic. Cluster 2 (green) main keywords are related to the diagnosis and differential diagnosis of MPS, such as myofascial pain, fibromyalgia, myofascial trigger point, muscle pain, and referred pain. Cluster 3 (blue) mainly involves the study methods and intervention measures of MPS research, such as randomized controlled trials, meta-analysis, systematic review, and acupuncture. Cluster 4 (yellow) mainly involves the quality of life of MPS patients, such as quality of life, depression, and anxiety. Figure 4E shows the top 24 keywords with the strongest citation bursts. Keyword bursts reflect hotspots, frontiers, and research trends. The keyword for the longest burst is "tender point (1992–2011)," which is as long as 20 years. Keywords in recent bursts include "dry needling (2016–2022)," "efficacy (2020–2022)," "validity (2020–2022)," "temporomandibular joint disorder (2020–2022)," and "orofacial pain (2020–2022)."

4. Discussion

In this study, we present the overall findings of MPS since 1956. The annual publication volume and literature trend can reflect the

Table 2

The top 10 prolific and co-cited authors on MPS research from 1956 to 2022.

	Author				Co-cited authors		
Rank	Name	Counts	Citations	Country	Name	Citations	Country
1	Hong CZ	20	1981	Taiwan	Simons DG	1078	USA
2	Calvo-lobo C	20	196	Spain	Hong CZ	488	Taiwan
3	Kumbhare D	14	75	Canada	Travell J	409	USA
4	Rodriguez-sanz D	12	127	Spain	Gerwin RD	377	USA
5	Lopez-lopez D	11	84	Spain	Wolfe F	348	USA
6	Fregni F	11	285	USA	Shah JP	305	USA
7	Dommerholt J	11	67	USA	Fernandez-de-las-penas C	260	Spain
8	Caumo W	10	279	Brazil	Fischer AA	207	USA
9	Fernandez-de-las-penas C	10	402	Spain	Friction JR	203	USA
10	Dibai-filho AV	9	71	Brazil	Mense S	177	Germany

MPS = Myofascial Pain Syndromes.

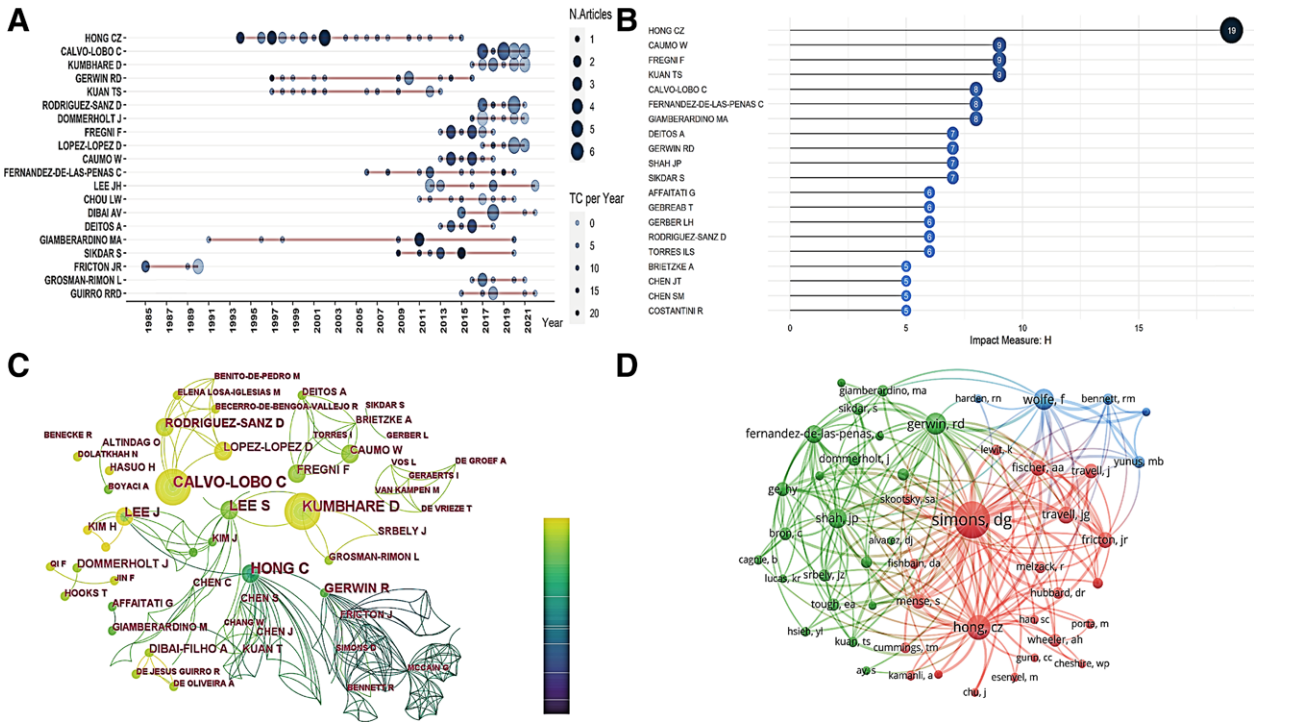


Figure 3. (A) Authors' Production over time involved in MPS. (B) Authors' H-index in MPS. (C) A CiteSpace visualization map of authors involved in MPS. Each node in the figure represents 1 author, and the larger the circle represents, the higher the "Degree" of the author. The lines between the circles represent the cooperative relationship between the authors. The color of nodes ranges from dark to light, representing the published literature from early to recent. (D) A VOSviewer visualization map of co-cited authors involved in MPS. Each node in the figure represents 1 author, and the node size positively correlates with the cited frequency. Each color represents a cluster, and the connection thickness between nodes positively correlates with the co-citation frequency. MPS = Myofascial Pain Syndromes.

Table 3

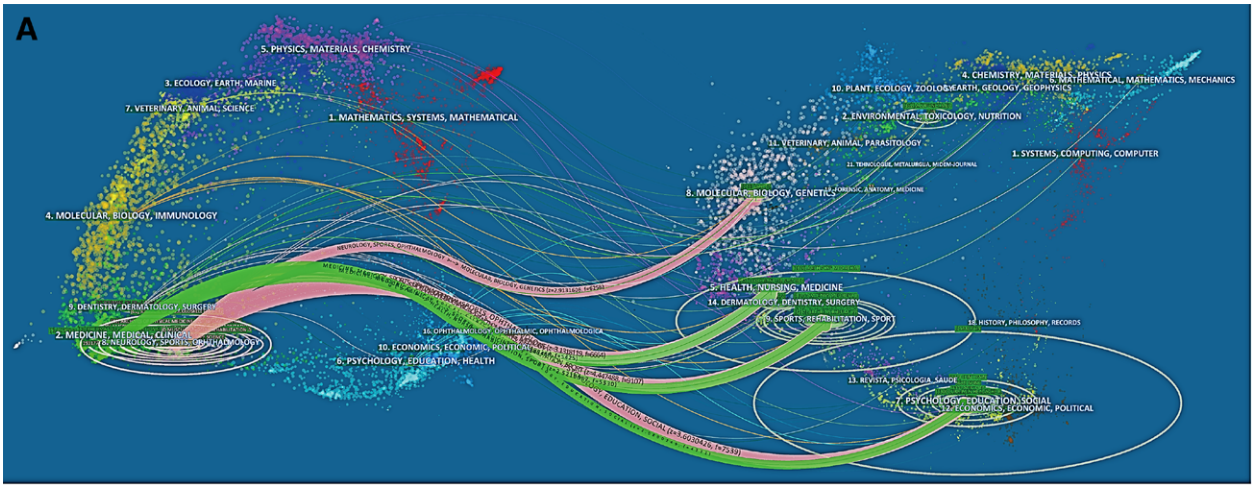
Top 10 journals and co-cited journals related to MPS.

	Journal					Co-cited Journal			
Rank	Name	Count	Citation	IF	JCR	Name	Co-citation	IF	JCR
1	*Journal of Musculoskeletal Pain*	61 (5.56%)	570	/	/	*Pain*	2598	7.926	Q1
2	*Archives of Physical Medicine and Rehabilitation*	47 (4.27%)	2182	4.06	Q1	*Archives of Physical Medicine and Rehabilitation*	1816	4.06	Q1
3	*Journal of Bodywork and Movement Therapies*	34 (3.09%)	212	/	/	*Clinical Journal of Pain*	848	3.423	Q2
4	*Pain Medicine*	34 (3.09%)	611	3.637	Q2	*American Journal of Physical Medicine & Rehabilitation*	837	3.421	Q3
5	*American Journal of Physical Medicine & Rehabilitation*	30 (2.73%)	1369	3.412	Q3	*Journal of Musculoskeletal Pain*	750	/	/
6	*Clinical Journal of Pain*	27 (2.45%)	1230	3.423	Q2	*Spine*	634	3.241	Q1
7	*Journal of Manipulative and Physiological Therapeutics*	25 (2.27%)	665	1.3	Q3	*Journal of Rheumatology*	629	5.346	Q2
8	*Journal of Back and Musculoskeletal Rehabilitation*	23 (2.09%)	210	1.456	Q4	*Journal of Bodywork and Movement Therapies*	513	/	/
9	*Current Pain and Headache Reports*	17 (1.55%)	720	3.904	Q2	*Journal of Manipulative and Physiological Therapeutics*	488	1.3	Q3
10	*Pain*	13 (1.19%)	1377	7.926	Q1	*Myofascial Pain and Fibromyalgia*	442	/	/

IF = impact factor, JCR = journal citation report, MPS = Myofascial Pain Syndromes.

development speed and research progress. From 1956 to 1980, the research was in its infancy, and the number of literature was minimal, mainly related reports or preliminary introductions of MPS, which had not attracted enough attention from scholars in this field.[5,6] From 1981 to 1995, MPS-related literature continued to be published, but the number of publications was still small, reflecting that people began to pay attention to MPS. In this stage, research hotspots are the clinical features of MPS and its identification with fibromyalgia, fibrositis, and other diseases.[11,12] In 2016 and beyond, the MPS research literature has increased significantly, mainly focusing on research on pathological mechanisms, diagnostic criteria, and treatment strategies.[2,4]

As shown in Table 1, the United States (n = 270, 24.57%) has the most significant number of publications, followed by



D **Top 22 References with the Strongest Citation Bursts**

References	Year	Strength	Begin	End	1956 - 2022
Wolfe F, 1992, J RHEUMATOL, V19, P944	1992	8.39	1994	1997	
Simons DG, 1996, J MUSCULOSKELET PAIN, V4, P93	1996	12.55	1998	2001	
Gerwin RD, 1997, PAIN, V69, P65	1997	10.39	1998	2002	
Hong CZ, 1998, ARCH PHYS MED REHAB, V79, P863	998	12.21	1999	2003	
Wheeler AH, 1998, SPINE, V23, P1662	1998	10.29	2000	2003	
Simons DG, 2004, J ELECTROMYOGR KINES, V14, P95	2004	8.24	2005	2009	
Shah JP, 2005, J APPL PHYSIOL, V99, P1977	2005	17.14	2006	2010	
Kamanli A, 2005, RHEUMATOL INT, V25, P604	2005	14.14	2007	2010	
Lavelle ED, 2007, MED CLIN N AM, V91, P229	2007	8.93	2008	2012	
Shah JP, 2008, ARCH PHYS MED REHAB, V89, P16	2008	16.14	2009	2013	
Tough EA, 2007, CLIN J PAIN, V23, P278	2007	10.42	2009	2012	
Sikdar S, 2009, ARCH PHYS MED REHAB, V90, P1829	2009	10.66	2010	2014	
Ballyns JJ, 2011, J ULTRAS MED, V30, P1331	2011	8.21	2012	2016	
Tekin L, 2013, CLIN RHEUMATOL, V32, P309	2013	12.43	2014	2018	
Kietrys DM, 2013, J ORTHOP SPORT PHYS, V43, P620	2013	12.43	2014	2018	
Ziaeifar M, 2014, J BODYW MOV THER, V18, P298	2014	8.84	2015	2019	
Liu L, 2015, ARCH PHYS MED REHAB, V96, P944	2015	10.19	2016	2020	
Gerwin RD, 2014, PHYS MED REH CLIN N, V25, P341	2014	9.41	2017	2019	
Rivers WE, 2015, PAIN MED, V16, P1794	2015	9.28	2017	2020	
Shah JP, 2015, PM&R, V7, P746	2015	13.35	2018	2020	
Cerezo-tellez E, 2016, PAIN MED, V17, P2369	2016	8.08	2018	2022	
Fernandez-de-las-penas C, 2018, PAIN MED, V19, P142	2018	15.56	2019	2022	

E **Top 24 Keywords with the Strongest Citation Bursts**

Keywords	Year	Strength	Begin	End	1956 - 2022
local twitch response	1956	4.64	1991	2008	
tender point	1956	7.08	1992	2011	
fibrositi	1956	6.67	1992	2003	
fibromyalgia	1956	10.38	1993	2009	
tension type headache	1956	5.81	2000	2010	
double blind	1956	11.6	2001	2012	
botulinum toxin	1956	6.7	2001	2007	
electrical nerve stimulation	1956	5.33	2002	2007	
skeletal muscle	1956	5.72	2006	2013	
botulinum toxin injection	1956	4.56	2007	2010	
referred pain	1956	5.51	2010	2015	
trigger point pain	1956	5.35	2010	2016	
mechanism	1956	5.25	2010	2014	
physical therapy	1956	5	2014	2016	
upper trapezius muscle	1956	5.08	2015	2018	
neck	1956	4.49	2015	2016	
dry needling	1956	6.51	2016	2022	
upper trapezius	1956	5.25	2016	2019	
manual therapy	1956	5.18	2016	2020	
physical therapy modality	1956	4.27	2017	2018	
efficacy	1956	5.64	2020	2022	
validity	1956	4.82	2020	2022	
temporomandibular joint disorder	1956	4.44	2020	2022	
orofacial pain	1956	4.3	2020	2022	

Figure 4. (A) The dual-map overlay of journals on MPS. On the journal's dual map overlay results, the citing graph is on the left, and the cited graph is on the right. The curve is the citation line, which completely shows the citation relationship. In the figure on the left, the more literature the journal publishes, the longer the vertical axis of the ellipse; the more the number of authors, the longer the horizontal axis of the ellipse. (B) The co-citation network visualization map of references on MPS research between 1956 and 2022. Each node in the map represents a paper, and the node's size is positively correlated with the citation frequency of the paper. Each color represents a cluster, and the thickness of the node connection is positively correlated with the co-citation frequency. (C) The co-occurrence network visualization map of keywords on MPS research between 1956 and 2022. Each node in the map represents a keyword, and the node's size is positively correlated with the frequency of keyword occurrence. Each color represents a cluster, and the thickness of the node connection is positively correlated with the number of times the keywords appear in the same paper. (D) The top 22 references with the strongest citation bursts on MPS research from 1956 to 2022. The red line in the figure represents the time when the reference bursts. (E) The top 24 keywords with the strongest citation bursts on MPS research from 1956 to 2022. The red line in the figure represents the time when the keyword bursts. MPS = Myofascial Pain Syndromes.

Turkey (n = 120, 10.92%) and Spain (n = 97, 8.83%), which together account for about 44.32% of the totality. These data indicate that the USA, Turkey, and Spain are most concerned about the evolution of the MPS field. Centrality is used to evaluate the importance of nodes in a network graph. The higher the value of centrality, the more important it is. As shown in

Table 4

Top 10 most cited references.

Rank	Cited reference	Citation	Year	Journal	First author
1	Lidocaine injection versus dry needling to myofascial trigger point. The importance of the local twitch response	136	1994	*Am J Phys Med Rehab*	Hong CZ
2	Interrater reliability in myofascial trigger point examination	127	1997	*Pain*	Gerwin RD
3	The American College of Rheumatology 1990 Criteria for the Classification of Fibromyalgia. Report of the Multicenter Criteria Committee	111	1990	*Arthritis Rheum-US*	Wolfe F
4	Mochemicals associated with pain and inflammation are elevated in sites near to and remote from active myofascial trigger points	106	2008	*Archives of Physical Medicine and Rehabilitation*	Shah JP
5	Myofascial trigger points in intercostal muscles secondary to herpes zoster infection of the intercostal nerve	105	1998	*Archives of Physical Medicine and Rehabilitation*	Hong CZ
6	prevalence of myofascial pain in general internal medicine practice	96	1989	*Western Journal of Medicine*	Skootsky SA
7	An in vivo microanalytical technique for measuring the local biochemical milieu of human skeletal muscle	94	2005	*Journal of Applied Physiology*	Shah JP
8	Needling therapies in the management of myofascial trigger point pain: A systematic review	93	2001	*Archives of Physical Medicine and Rehabilitation*	Cummings TM
9	Myofascial trigger points show spontaneous needle EMG activity	93	1993	*Spine*	Hubbard DR
10	Review of enigmatic MTrPs as a common cause of enigmatic musculoskeletal pain and dysfunction	85	2004	*Journal of Electromyography and Kinesiology*	Simons DG

Table 1, among the countries with the highest top 10 publications, the USA has the highest centrality (0.62), which indicates that the USA dominates the MPS research area worldwide. As the world's largest economy, the USA has many research institutions and has the strength to invest much money in research. As shown in Figure 2C, 5 of the top 14 research institutions are in the USA. As shown in Figure 2D, there are relatively many connections between institutions, indicating relatively frequent academic cooperation and communication between institutions. Cooperation between countries or institutions is conducive to overcoming scientific research challenges, reaching a consensus on academic viewpoints, and giving full play to the advantages of various countries or institutions. It also indicates that some problems in this field need to be solved together.

Analyzing the author is helpful in finding crucial experts in the field of MPS research. Crucial experts play a leading role in a particular field and determine the development direction of the field. Analysis of important literature published by crucial experts can quickly and deeply understand the research progress, development trends, and research hotspots in this field, which is beneficial to grasp the future research direction better. As can be seen from Table 2 and Figure 3A, Hong CZ and Calvo-Lobo C are the most prolific authors. Hong CZ published papers focused on 1993 to 2015, mainly focusing on the efficacy and clinical features of MPS, expanding around trigger points and biased toward the macro level.[7,13] Calvo-Lobo C published papers mainly focus on 2017 and beyond, Mainly research on special MPS or taking a certain direction as an entry point, focusing on the micro-level.[14,15] Research of the papers of the 2 crucial authors shows that the MPS-related research is from macro to micro, and the research direction has become more specific and refined. Although their publications are equal, the influence of Hong CZ is significantly greater than that of Calvo-Lobo C, mainly reflected in that Hong CZ's H-index and citation times were markedly higher than Calvo-Lobo C's. The possible reason is that the papers published by Hong CZ are macroscopic or have important value and are easily concerned with by scholars. It is also not ruled out that Hong CZ's papers are mainly published in the early stage, which has more time for people to pay attention. If you want to get a general understanding of the field quickly, it is recommended to read papers of Hong CZ, and if you want to understand the new hot topics in this research field, it is recommended to read papers of Calvo-Lobo C. As shown in Figure 3C, the lines between authors are relatively dense, suggesting that the cooperation between authors is relatively frequent. The connected authors form an independent network; there is no connection between the independent networks, suggesting that there is still room for cooperation between authors. The task for the future is to promote cooperation, reach a consensus, and unify international standards for diagnosis and treatment. As shown in Table 2 and Figure 3D, Simons DG has been co-cited more than 1000 times and is the most co-cited author, suggesting that the content of his research has an important impact on the field. His research results are earlier, and the direction tends to be macro. It plays a leading role in this field and plays a bridge function in related research fields. Reading Simons DG's article can promptly hold crucial information in the field.

The study of publications sources can help scholars find essential journals in their research field. As seen in Table 3, the *Journal of Musculoskeletal Pain* publishes the most literature, suggesting that it is a popular journal for submissions. *Pain* is a high-quality journal in this field, with the most co-cited papers and the highest impact factor. It can be used as an authoritative reference in this field. There are 3 journals from Q1: *Pain, Archives of Physical Medicine and Rehabilitation,* and *Spine*. Researchers in this field highly recommend these Q1 journals. In addition, 7 journals were in the top 10 of both prolific and co-cited journals: *Journal of Musculoskeletal Pain, Archives of Physical Medicine and Rehabilitation, Clinical Journal of Pain, American Journal of Physical Medicine & Rehabilitation, Journal of Musculoskeletal Pain, Journal of Bodywork and Movement Therapies, Journal of Manipulative and Physiological Therapeutics*. The above journals are important journals for publishing MPS research literature.

Highly cited reference is often the classical literature in a particular field, which lays the research's knowledge structure and theoretical foundation. It is informative and important, plays a rapid role in promoting the development of the research field, and determines the evolution direction of the area. The critical points in this research field can be quickly comprehended by studying and analyzing highly cited references. As shown in Table 4, most of the ten most cited papers are related to the diagnosis and treatment of MPS and trigger points.[7,8] The most cited literature is *Lidocaine injection versus dry needling to myofascial trigger point: The importance of the local twitch*

response. This study compared and confirmed the effectiveness of lidocaine injection and dry needling in the treatment of MPS, indicating the possible mechanism of lidocaine injection and dry needling in the treatment of MPS and concluded that elicited local twitch responses could obtain the best efficacy.[7] This study has a milestone significance in the field of MPS-related research, laying a theoretical foundation for the research related to lidocaine injection and dry needling for treating MPS. Since then, lidocaine injection and dry needling have become the primary treatment approaches for MPS. An extensive number of related papers have emerged. Literature with citation bursts is the node literature that suddenly changes the number of citations. Such nodes usually indicate the emergence or transformation of a research field and are characterized by importance and innovation. As shown in Figure 4D, "Shah JP, 2005, J APPL PHYSIOL, V99, P1977" has the strongest citation burst. This study introduced a method to monitor differences in the amounts of bradykinin, CGRP, SP, TNF-α, IL-1β, serotonin, and norepinephrine in local tissues between those with active MTrPs versus those who have latent or no MTrPs; even monitor changes in analyte amounts before, during and after the LTR.[8] This achievement is expected to have substantial value in diagnosing and treating MPS. At that time, due to its innovation, it attracted the wide attention of scholars for some time. Literature with the most recent burst is usually some recent findings or ideas that have attracted the attention of scholars. Research on literature with the most recent burst is helpful in understanding the latest developments in this field and provides a reference for grasping the future research direction. As shown in Figure 4D, literature with the most recent burst includes "Cerezo-Tellez E, 2016, PAIN MED, V17, P2369," which has been in bursts from 2016 to now; "Fernandez-las-penas C, 2018, PAIN MED, V19, P142" which has been in bursts from 2018 to now. The results of the study by Cerezo-Tellez et al[9] showed a 100% prevalence of MPS in patients with chronic nonspecific neck pain, and all participants in this study presented with MTrPs in the trapezius, multifidus, cervical splint, or levator scapulae muscles associated with their neck pain, concluding that MPS examination is essential in the diagnosis of chronic nonspecific neck pain. This study, combined with our clinical experience, believes that almost all chronic nonspecific neck pain has MTrPs of MPS. Therefore, extinguishing MTrPs is also the key to treating nonspecific neck pain. The essence of chronic nonspecific neck pain may be MPS, and it will be significant to study the relationship between MPS and chronic nonspecific pain in the future. A Delphi Study involving 60 MPS experts from 12 countries is the first consensus on the diagnostic criteria and some clinical aspects of MPS. It mainly involves the definition of MTrPs, the difference between active and latent MTrPs, and referred pain.[10] The literature of Fernandez-las-Penas et al with citation burst reflects the importance of promoting cooperation, reaching a consensus and unifying diagnosis and treatment standards in the field of MPS research. It can be speculated that the urgent task in the future is to involve a broader range of international experts and develop a more authoritative, high-quality, practical and highly accepted MPS diagnosis and treatment guide or expert consensus.

The keywords' co-occurrence network and bursts reflect the research hotspots and evolution trends in the area of MPS. As seen in Figure 4C, the "trigger point" is the most prominent except for the subject word "MPS." As shown in Figure 4E, the keyword with the most prolonged burst duration is the "tender point," which is often the trigger point. It reflects the international attention and recognition of the importance of trigger points in MPS research. The trigger point plays a vital role in the pathogenesis, diagnosis, and treatment of MPS. The trigger point is robust evidence for the diagnosis of MPS and a key target for the implementation of treatment, which is involved in the pathogenesis of MPS.[16] As early as the 1950s, Travell and Rinzler[5] pointed out that myofascial structures' trigger areas can indefinitely maintain pain cycles. In 1979, Wyatt WE introduced the clinical significance of trigger points in detail.[17] Hong and Simons[18] believed that the trigger point is the response of the spinal cord to the abnormally sensitive nerve fibers of the endplate through an integration mechanism. Fernández-De-Las-Peñas and Dommerholt[19] showed that trigger points could induce central sensitization, and central sensitization can promote the activation of trigger points. In recent years, the anatomical research of MTrP has been further deepened. Through trigger point biopsy, pathological changes different from normal tissues can often be found, such as local hyperplasia, ischemia, and the formation of fat deposition. However, the pathogenesis of trigger points is still not completely clear, and more research is needed. In clinical practice, the accurate location of trigger points is the key to the successful treatment of MPS. Further exploration of the pathophysiology of trigger points may lead to more effective therapies for MPS. So far, the most classical interventions for MPS include physical therapy, injection therapy, acupuncture therapy, minimally invasive interventional therapy, and drug therapy. Shock wave therapy has attracted more and more attention due to its simplicity, safety, rapid effect, and non-invasiveness, and it has gradually become the most crucial physical therapy method.[20] If the effect of shock waves and other physical therapy is not good, trigger point injection therapy and minimally invasive interventional therapy can be given. Refractory MPS can be treated with heated silver needles or radiofrequency thermocoagulation ablation.[5] The recent bursts of keywords are "dry needling," "efficacy," and" validity," suggesting that the therapeutic effect of MPS has received more attention recently. The treatment of dry needling of MPS has been focused on recently, and as shown in Figure 4E, it has bursts since 2016. Dry needling is a solid filiform needle that has become a popular treatment method. More and more studies have shown that its clinical efficacy is significant. Dry needling therapy for MPS is mainly by reducing pain and muscle tone and improving range of motion, muscle strength, and coordination.[21] The needle insertion depth and stimulation intensity are significant for muscle pain relief. The deeper the needle is inserted, the better the treatment effect. Compared with shallow stimulation, deep stimulation has a better analgesic effect.[22] Dry needling produces the best therapeutic effect when eliciting a localized twitching reaction. The newly bursts keywords "temporomandibular joint disorder" and "orofacial pain" suggest that related research is the latest hotspot. Temporomandibular joint disorder (TMD), an MPS, is a general term describing pain and masticatory dysfunction, with an incidence of approximately 25%.[23] Its etiology is unclear and may be related to habits, occlusion, psychological, genetic, hormonal, and other factors. In addition, some studies suggest that emotional stress disorders may cause bad habits, muscle hyperactivity, and micro-occlusal trauma.[24] Thus, elevated levels of stress, anxiety, and depression may be associated with signs and symptoms of TMD.[25] TMD is a complex joint disease, and intra-articular injection for TMD has excellent prospects and is the primary treatment method.[26] Masticatory myofascial pain syndrome (MMPS) is a musculoligamentous syndrome that can present similarly to odontogenic pain or refer to pain in the ears, eyebrows, temporomandibular joints, maxillary sinus, tongue, and hard palate.[27] Among patients seeking treatment for temporomandibular joint and orofacial pain, 30%-55% have MMPS.[28] Currently, the most comprehensive theory of pathophysiology describing MMPS is the *expanded integrated hypothesis*. The *Diagnostic Criteria for Temporomandibular Disorders* is the most widely accepted diagnostic guideline for MMPS. However, its diagnostic capability is limited. Therefore, palpation by compression, finding MTrP nodes and taut bands to elicit "familiar pain," while local twitch response remains the cornerstone of the diagnosis.[29] There is no uniform standard of therapy strategies because each patient needs tailoring and multidisciplinary management to regress the muscle's range of

motion, inactivate MTrP, and relieve pain. TMD and MMPS are MPS of particular types, representing the latest research hotspots, and are the concrete embodiment of MPS research from macro to micro.

4.1. Study limitations

First, because WOSCC is the most suitable for bibliometric analysis, this study only analyzed the literature in the WOSCC database; no other databases are analyzed, so a more comprehensive MPS bibliometric analysis remains to be studied.

Second, the WOSCC database is biased toward journals published in English, and countries with a strong tradition of publishing in their native languages, such as China, Russia, and Japan, may have underestimated their influence and contributions.

Finally, although we have enriched the search strategy as much as possible, there are still differences between the search results and the ideal results.

5. Conclusion

This study summarizes and visualizes the development, research hotspots, and future trends of the global MPS research field from 1956 to 2022. The study concludes that the relevant research on MPS mainly focuses on its pathogenesis, diagnosis and treatment. Trigger points play an essential role in the pathogenesis, diagnosis and treatment of MPS. Recent research hotspots include dry needling for MPS, the therapeutic effectiveness of MPS, and research on diseases closely related to MPS (TMD, MMPS and chronic nonspecific neck pain). Essential tasks for this research field's future are strengthening more comprehensive and extensive cooperation between countries, institutions and authors, conducting in-depth research on the pathogenesis, formulating authoritative international diagnostic criteria, and reaching a broad consensus on treatment.

6. Suppliers

a. CiteSpace (version 6.1.R3).
b. VOSviewer (version 1.6.16).
c. Bibliometrics (version 1.7).
d. R tool of R-Studio (Version 4.1.3).
e. Microsoft Excel 2021.

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References

[1] Borg-Stein J, Simons DG. Myofascial pain. Arch Phys Med Rehabil. 2002;83:S40–7.
[2] Galasso A, Urits I, An D, et al. A comprehensive review of the treatment and management of myofascial pain syndrome. Curr Pain Headache Rep. 2020;24:43.
[3] Saxena A, Chansoria M, Tomar G, et al. Myofascial pain syndrome: an overview. J Pain Palliat Care Pharmacother. 2015;29:16–21.
[4] Cao Q-W, Peng B-G, Wang L, et al. Expert consensus on the diagnosis and treatment of myofascial pain syndrome. World J Clin Cases. 2021;9:2077–89.
[5] Travell J, Rinzler SH. The myofascial genesis of pain. Postgrad Med. 1952;11:425–34.
[6] Sola AE, RL W. Myofascial pain syndromes. Neurology. 1956;6:91–5.
[7] Hong CZ. Lidocaine injection versus dry needling to myofascial trigger point. The importance of the local twitch response. Am J Phys Med Rehabil. 1994;73:256–63.
[8] Shah JP, Phillips TM, Danoff JV, et al. An in vivo microanalytical technique for measuring the local biochemical milieu of human skeletal muscle. J Appl Physiol (1985). 2005;99:1977–84.
[9] Cerezo-Tellez E, Torres-Lacomba M, Mayoral-del Moral O, et al. Prevalence of myofascial pain syndrome in chronic non-specific neck pain: a population-based cross-sectional descriptive study. Pain Med. 2016;17:2369–77.
[10] Fernandez-de-las-Penas C, Dommerholt J. International consensus on diagnostic criteria and clinical considerations of myofascial trigger points: a Delphi study. Pain Med. 2018;19:142–50.
[11] Yunus MB, Kalyanraman UP, Kalyanraman K. Primary fibromyalgia syndrome and myofascial pain syndrome: clinical features and muscle pathology. Arch Phys Med Rehabil. 1988;69:451–4.
[12] Thompson JM. Tension myalgia as a diagnosis at the Mayo Clinic and its relationship to fibrositis, fibromyalgia, and myofascial pain syndrome. Mayo Clin Proc. 1990;65:1237–48.
[13] Gerwin RD, Shannon S, Hong CZ, et al. Interrater reliability in myofascial trigger point examination. Pain. 1997;69:65–73.
[14] Sánchez-Romero EA, Pecos-Martín D, Calvo-Lobo C, et al. Clinical features and myofascial pain syndrome in older adults with knee osteoarthritis by sex and age distribution: a cross-sectional study. Knee. 2019;26:165–73.
[15] Benito-de-Pedro M, Becerro-de-Bengoa-Vallejo R, Losa-Iglesias ME, et al. Effectiveness between dry needling and ischemic compression in the triceps surae latent myofascial trigger points of triathletes on pressure pain threshold and thermography: a single blinded randomized clinical trial. J Clin Med. 2019;8:1632.
[16] Valera-Calero JA, Sánchez-Jorge S, Buffet-García J, et al. Changes in stiffness at active myofascial trigger points of the upper trapezius after dry needling in patients with chronic neck pain: a randomized controlled trial. Acupunct Med. 2022;40:9645284221104831.
[17] WE W. Case-report of a trigger point of clinical significance. Amer Osteopathic Assn. 1979;79:109–10.
[18] Hong CZ, Simons DG. Pathophysiologic and electrophysiologic mechanisms of myofascial trigger points. Arch Phys Med Rehabil. 1998;79:863–72.
[19] Fernández-de-las-Peñas C, Dommerholt J. Myofascial trigger points: peripheral or central phenomenon? Curr Rheumatol Rep. 2014;16:395.
[20] Wu T, Li S, Ren J, et al. Efficacy of extracorporeal shock waves in the treatment of myofascial pain syndrome: a systematic review and meta-analysis of controlled clinical studies. Ann Transl Med. 2022;10:165.
[21] Cagnie B, Dewitte V, Barbe T, et al. Physiologic effects of dry needling. Curr Pain Headache Rep. 2013;17:348.
[22] Itoh K, Minakawa Y, Kitakoji H. Effect of acupuncture depth on muscle pain. Chin Med. 2011;6:24.
[23] Scrivani SJ, Keith DA, LB K. Medical progress: temporomandibular disorders. N Engl J Med. 2008;359:2693–705.
[24] Stoustrup P, Kristensen KD, Verna C, et al. Intra-articular steroid injection for temporomandibular joint arthritis in juvenile idiopathic arthritis: a systematic review on efficacy and safety. Semin Arthritis Rheum. 2013;43:63–70.
[25] Calixtre LB, Grüninger BL, Chaves TC, et al. Is there an association between anxiety/depression and temporomandibular disorders in college students? J Appl Oral Sci. 2014;22:15–21.
[26] Dashnyam K, Lee JH, Mandakhbayar N, et al. Intra-articular biomaterials-assisted delivery to treat temporomandibular joint disorders. J Tissue Eng. 2018;9:2041731418776514.
[27] Elbarbary M, Oren A, Goldberg M, et al. Masticatory myofascial pain syndrome: implications for endodontists. J Endod. 2022;48:55–69.
[28] Bush FM, Whitehill JM, Martelli MF. Pain assessment in temporomandibular disorders. Cranio. 1989;7:137–43.
[29] Schiffman E, Ohrbach R, Truelove E, et al.; International RDC/TMD Consortium Network, International association for Dental Research. 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 groupdagger. J Oral Facial Pain Headache. 2014;28:6–27.