Top 100 cited articles on osteoarthritis from 1990 to 2020

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Abstract

Objectives: The purpose of this study was to identify and analyze the 100 top-cited articles in the field of osteoarthritis (OA) from 1990 to 2020.

Methods: We used the Web of Science to retrieve the articles related to OA. Then we selected 100 target articles and manually collected their general information, including article title, author, year of publication, journal, type of article, and the number of citations.

Results: The 100 top-cited articles were published in the period from 1990 to 2015. These articles have been cited 66,494 times in total, with the highest being 2382 times, the lowest being 433 times, the median number being 613, and a mean of 664.94 times. The 100 top-cited articles appeared in a total of 35 influential journals. The greatest number of articles in the top of 100 was published in Arthritis and Rheumatism. The authors of these articles came from 18 countries, led by the United States ($n = 48$), followed by the United Kingdom ($n = 15$). Among all the institutions, Boston University led the list with 10 articles. The most prevalent type of the study was review ($n = 38$) and clinical study ($n = 38$), followed by guideline ($n = 12$), basic science ($n = 10$) and other types.

Conclusions: This study provided some insights on the literature development and citation of OA in the recent 30 years. Articles published in high-impact journals are more likely to be cited in the field of OA. As recent studies did not have enough time to accumulate the number of citations, the latest articles may not be included in the top 100 cited articles.

Keywords

arthritis • bibliometrics • osteoarthritis • Top-cited

Background

Osteoarthritis (OA) is an age-associated disease characterized by chronic joint pain resulting from degradation of articular cartilage, inflammation of the synovial lining, and changes to the subchondral bone.^[1] OA is the osteoarticular disease with the highest prevalence worldwide.^[2] In addition to being a major source of disability, OA reduced work productivity and lost physical fitness at the individual level, and increased health and welfare costs at the societal level.^[3, 4]

Bibliometrics is a quantitative tool for the analysis of literature published in a scientific field.^[5] Bibliometrics can be

defined as the combination of statistics and philology, which uses statistical methods to study the relationship between literature and information.^[6] In the last 30 years, many articles have been published on OA. At present, to the best of our knowledge, there were several analyses of the 100 top-cited articles in various specialties, such as urological surgery,^[7] endodontics,^[8] gastric disease,^[9] sleep medicine,^[10] and robotic surgery.^[11] However, no comprehensive study of the top-cited articles in the field of OA has appeared to date. The purpose of this study was to identify and analyze the 100 articles on OA. And the expectation was that this study could provide a reference for the development of OA in the future.

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Materials and Methods

We started searching for information on July 1, 2020. The whole information about the citations was collected from July 1, 2020 to July 15, 2020. The Web of Science was used by us to retrieve articles with “OA” as the subject, and the period was from January 1, 1990 to July 1, 2020. Only articles that focused on the subject of OA and were edited in English were included. The retrieved articles

were ranked in descending order according to the number of citations. We selected the top 100 related articles and manually collected their basic information, including titles, the number of citations, authors, journals, and year of publication. Two reviewers (Feng Yin and Qiuyu Yang) independently selected the top 100 cited articles about OA. When there were disagreements between two reviewers, a third reviewer (Yue He) joined and helped achieve consensus. After identifying the 100 target articles, we viewed

Table 1: Top 100 cited articles in the field of OA

Rank	Article	No. of citations
1	Gastrointestinal toxicity with celecoxib vs nonsteroidal anti-inflammatory drugs for osteoarthritis and rheumatoid arthritis: the CLASS study: A RCT.	2382
2	Femoroacetabular impingement: a cause for osteoarthritis of the hip.	1781
3	Knee Injury and Osteoarthritis Outcome Score (KOOS) – development of a self-administered outcome measure.	1689
4	OARSI recommendations for the management of hip and knee osteoarthritis, Part II: OARSI evidence-based, expert consensus guidelines.	1655
5	American College of Rheumatology 2012 recommendations for the use of nonpharmacologic and pharmacologic therapies in osteoarthritis of the hand, hip, and knee.	1566
6	Osteoarthritis: new insights. Part 1: the disease and its risk factors.	1491
7	Recommendations for the medical management of osteoarthritis of the hip and knee: 2000 update. American College of Rheumatology Subcommittee on Osteoarthritis Guidelines.	1452
8	OARSI guidelines for the non-surgical management of knee, hip, and polyarticular osteoarthritis.	1346
9	EULAR Recommendations 2003: an evidence-based approach to the management of knee osteoarthritis: Report of a Task Force of the Standing Committee for International Clinical Studies Including Therapeutic Trials (ESCISIT).	1314
10	The American College of Rheumatology criteria for the classification and reporting of osteoarthritis of the hip.	1310
11	A controlled trial of arthroscopic surgery for osteoarthritis of the knee.	1206
12	The long-term consequence of anterior cruciate ligament and meniscus injuries: osteoarthritis.	1163
13	Role of proinflammatory cytokines in the pathophysiology of osteoarthritis.	1071
14	The global burden of hip and knee osteoarthritis: estimates from the global burden of disease 2010 study.	1061
15	Osteoarthritis cartilage histopathology: grading and staging.	1024
16	Osteoarthritis: an update with relevance for clinical practice.	982
17	OARSI recommendations for the management of hip and knee osteoarthritis: part III: Changes in evidence following systematic cumulative update of research published through January 2009.	977
18	A randomized trial comparing aerobic exercise and resistance exercise with a health education program in older adults with knee osteoarthritis.	946
19	Osteoarthritis: a disease of the joint as an organ.	925
20	An update on the epidemiology of knee and hip osteoarthritis with a view to prevention.	874
21	Osteoarthritis.	855
22	Long-term effects of glucosamine sulfate on osteoarthritis progression: a randomized, placebo-controlled clinical trial.	854
23	The role of knee alignment in disease progression and functional decline in knee osteoarthritis.	850
24	WORMS of the knee in osteoarthritis.	847
25	Dynamic load at baseline can predict radiographic disease progression in medial compartment knee osteoarthritis.	845
26	High prevalence of knee osteoarthritis, pain, and functional limitations in female soccer players twelve years after an anterior cruciate ligament injury.	840
27	Deletion of active ADAMTS5 prevents cartilage degradation in a murine model of osteoarthritis.	837
28	The KOOS: from joint injury to osteoarthritis.	834
29	Enhanced cleavage of type II collagen by collagenases in osteoarthritic articular cartilage.	798
30	Osteoarthritis, an inflammatory disease: potential implication for the selection of new therapeutic targets.	790
31	Knee pain and osteoarthritis in older adults: a review of community burden and current use of primary health care.	790
32	The American College of Rheumatology criteria for the classification and reporting of osteoarthritis of the hand.	790
33	Glucosamine, chondroitin sulfate, and the two in combination for painful knee osteoarthritis.	783
34	Cloning, expression, and type II collagenolytic activity of matrix metalloproteinase-13 from human osteoarthritic cartilage.	766
35	The role of cytokines in osteoarthritis pathophysiology.	764
36	Stem cell therapy in a caprine model of osteoarthritis.	760
37	Articular cartilage: degeneration and osteoarthritis, repair, regeneration, and transplantation.	705

(Continued)

Rank	Article	No. of citations
38	Human autologous culture expanded bone marrow mesenchymal cell transplantation for repair of cartilage defects in osteoarthritic knees.	704
39	Acetabular and femoral anteversion: relationship with osteoarthritis of the hip.	692
40	Atlas of individual radiographic features in osteoarthritis.	676
41	Epidemiology of osteoarthritis.	658
42	Guidelines for the medical management of osteoarthritis. Part II. Osteoarthritis of the knee. American College of Rheumatology.	655
43	The etiology of osteoarthritis of the hip: an integrated mechanical concept.	655
44	Exercise and dietary weight loss in overweight and obese older adults with knee osteoarthritis: the Arthritis, Diet, and Activity Promotion Trial.	652
45	Osteoarthritis as an inflammatory disease (osteoarthritis is not osteoarthrosis!).	642
46	The association of bone marrow lesions with pain in knee osteoarthritis.	633
47	Quadriceps weakness and osteoarthritis of the knee.	632
48	Pathogenesis and management of pain in osteoarthritis.	625
49	Weight loss reduces the risk for symptomatic knee osteoarthritis in women. The Framingham Study.	618
50	Risk factors for the onset of osteoarthritis of the knee in older adults: a systematic review and meta-analysis.	617
51	Atlas of individual radiographic features in osteoarthritis, revised.	609
52	Osteoarthritis: epidemiology.	609
53	Osteoarthritis.	608
54	A framework for the in vivo pathomechanics of osteoarthritis at the knee.	593
55	Glucosamine and chondroitin for treatment of osteoarthritis: a systematic quality assessment and meta-analysis.	589
56	EULAR evidence-based recommendations for the management of hip osteoarthritis: report of a task force of the EULAR Standing Committee for International Clinical Studies Including Therapeutics (ESCIIT).	577
57	Recommendations for a core set of outcome measures for future phase III clinical trials in knee, hip, and hand osteoarthritis. Consensus development at OMERACT III.	571
58	Articular cartilage and changes in arthritis. An introduction: cell biology of osteoarthritis.	565
59	Inflammation in osteoarthritis.	562
60	Synovial tissue inflammation in early and late osteoarthritis.	560
61	Osteoarthritis chondrocytes die by apoptosis. A possible pathway for osteoarthritis pathology.	555
62	Matrix metalloproteinase and proinflammatory cytokine production by chondrocytes of human osteoarthritic cartilage: associations with degenerative changes.	548
63	The OARSI histopathology initiative - recommendations for histological assessments of osteoarthritis in the mouse.	544
64	Metal-on-metal resurfacing of the hip in patients under the age of 55 years with osteoarthritis.	533
65	Evaluation of clinically relevant changes in patient-reported outcomes in knee and hip osteoarthritis: the minimal clinically important improvement.	533
66	The role of synovitis in pathophysiology and clinical symptoms of osteoarthritis.	529
67	Risk factors for incident radiographic knee osteoarthritis in the elderly: the Framingham Study.	523
68	Sensitization in patients with painful knee osteoarthritis.	523
69	The surgical DMM model of osteoarthritis in the 129/SvEv mouse.	522
70	Incidence of symptomatic hand, hip, and knee osteoarthritis among patients in a health maintenance organization.	519
71	Increased damage to type II collagen in osteoarthritic articular cartilage detected by a new immunoassay.	516
72	The role of the chondrocyte in osteoarthritis.	513
73	EULAR recommendations for the non-pharmacological core management of hip and knee osteoarthritis.	512
74	Bone marrow edema and its relation to progression of knee osteoarthritis.	511
75	Lifetime risk of symptomatic knee osteoarthritis.	503
76	Prevalence of knee osteoarthritis in the United States: arthritis data from the Third National Health and Nutrition Examination Survey 1991–94.	499
77	Viscosupplementation: a new concept in the treatment of osteoarthritis.	498
78	High prevalence of osteoarthritis 14 years after an anterior cruciate ligament tear in male soccer players: a study of radiographic and patient-relevant outcomes.	491
79	Glucosamine sulfate use and delay of progression of knee osteoarthritis: a 3-year, randomized, placebo-controlled, double-blind study.	489
80	OARSI recommendations for the management of hip and knee osteoarthritis, part I: critical appraisal of existing treatment guidelines and systematic review of current research evidence.	487
81	OMERACT-OARSI initiative: Osteoarthritis Research Society International set of responder criteria for osteoarthritis clinical trials revisited.	484
82	The incidence and natural history of knee osteoarthritis in the elderly. The Framingham Osteoarthritis Study.	481
83	Knee adduction moment, serum hyaluronan level, and disease severity in medial tibiofemoral osteoarthritis.	480
84	A meta-analysis of sex differences prevalence, incidence, and severity of osteoarthritis.	476
85	Risk factors for the incidence and progression of radiographic knee osteoarthritis.	476

(Continued)

Rank	Article	No. of citations
86	The WOMAC: a review of its utility and measurement properties.	467
87	Morphologic study of the glenoid in primary glenohumeral osteoarthritis.	466
88	Knee osteoarthritis after meniscectomy: prevalence of radiographic changes after twenty-one years, compared with matched controls.	459
89	Genetic influences on osteoarthritis in women: a twin study.	458
90	The role of synovitis in osteoarthritis pathogenesis.	456
91	Knee osteoarthritis after anterior cruciate ligament injury: a systematic review.	453
92	Comparison of an antiinflammatory dose of ibuprofen, an analgesic dose of ibuprofen, and acetaminophen in the treatment of patients with osteoarthritis of the knee.	452
93	Design and conduct of clinical trials in patients with osteoarthritis: recommendations from a task force of the Osteoarthritis Research Society. Results from a workshop.	452
94	What proportion of patients reports long-term pain after total hip or knee replacement for osteoarthritis? A systematic review of prospective studies in unselected patients.	451
95	HOOS – validity and responsiveness in total hip replacement.	450
96	Increased knee joint loads during walking are present in subjects with knee osteoarthritis.	441
97	Posttraumatic osteoarthritis: a first estimate of incidence, prevalence, and burden of disease.	441
98	Clinical practice. Osteoarthritis of the knee.	438
99	Analysis of the discordance between radiographic changes and knee pain in osteoarthritis of the knee.J.	438
100	The role of inflammatory and anti-inflammatory cytokines in the pathogenesis of osteoarthritis.	438

DMM, destabilization of the medial meniscus; HOOS, Hip disability, and osteoarthritis outcome score; KOOS, Knee injury and Osteoarthritis Outcome Score; OA, osteoarthritis; RCT, randomized controlled trial; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; WORMS, Whole-Organ Magnetic Resonance Imaging Score.

Figure 1: The process of article collection.

the full text by linking to other search platforms such as PubMed. Then we collected some information, including institutions, type of articles, countries, and study content. All the collected information was sorted into a spreadsheet and further analyzed. More details of the top 100 cited articles in the field of OA are shown in Table 1. The process of data collection is shown in Figure 1.

The types of the target articles were categorized into review, clinical research, basic science, guidelines and consensus, and other types. Clinical research was divided into a prospective study, retrospective study, randomized controlled study, and case report. The theme of these articles included etiology/harm, pathophysiology, epidemiology, diagnosis and treatment, and the prognosis of OA.

Results and Discussion

Authors, Countries and Institutions

There were 84 first authors. And seven of them owned two or more top-cited articles. Felson DT was the first author for six articles, whose articles had the highest number of total citations. More details are shown in Table 2.

Eighteen different countries contributed to the target articles. Most of them were from The United States ($n = 48$), followed by The United Kingdom ($n = 15$). The number of papers in each country was 48 in the United States, 15 in the United Kingdom, 8 in Canada, 7 in Sweden, 5 in France, 2 in Japan, 2 in Norway, 2 in Australia, 2 Switzerland, and 10 in others.

These articles came from 73 institutions (the institutions of the corresponding authors), led by Boston University in the United States ($n = 10$), followed by Lund University in Sweden ($n = 6$). Fourteen different institutions contributed two or more the top-cited articles, respectively. More details are shown in Table 3.

Journals and Publication Years

The 100 papers appeared in a total of 35 journals. The journal with the largest number of the target articles was Arthritis

& rheumatism ($n = 20$, including before and after the name change), followed by OA and cartilage ($n = 17$), Annals of the rheumatic disease ($n = 9$), Annals of internal medicine ($n = 5$), Lancet ($n = 4$), The New England journal of medicine ($n = 4$), The Journal of rheumatology ($n = 4$), JAMA ($n = 4$) and others ($n = 32$). The impact factors of these journals were ranging from 74.699 to 0. More details were shown in Table 4.

The span of publication date of these target articles was from Nov 1990 to Jul 2015. We demonstrated that most of the highly cited articles ($n = 74$) were published after 2000. Fifty-five articles were published from 2000 to 2009 and 19 articles were published in 2010 and later (Figure 2). The latest article was a clinical study on the adverse reaction of drugs in the treatment of OA, and it was published in 2015. The earliest article, which was published in 1990, was about the classification and reporting of hand OA.

Table 3: Institution with more than two articles

Rank	Institutions	No. of articles	Total citations
1	Boston University	10	6816
2	Lund University	6	4763
3	University of Maryland	2	2221
4	University of Edinburgh	2	2142
5	Bowman Gray School of Medicine	2	1871
6	de l'Universite de Montreal	2	1554
7	Mount Sinai Hospital	2	1491
8	Keele University	2	1407
9	University of Iowa	2	1171
10	Sorbonne Universite Univ Paris	2	1146
11	Northwestern University	2	1130
12	University of Southampton	2	1085
13	Indiana University School of Medicine	2	1084
14	University of Bristol	2	1076

Table 2: Authors with two or more top-cited articles

Rank	Author	No. of articles	Document serial number	Total citations
1	Felson, DT	6	6, 20, 46, 49, 67, 82	4617
2	Altman, R	5	10, 32, 40, 51, 93	3819
3	Zhang, W	4	4, 17, 56, 80	3687
4	Ganz, Reinhold	2	2, 43	2433
5	Goldring, Mary B	2	21, 59	1415
6	Sharma, L	2	23, 83	1321
7	Daniel, J	2	63, 69	1052

Table 4: Journals with more than two articles

Rank	Journals	2019 Impact Factor	No. of articles	The serial number of articles
1	Arthritis and rheumatism	9.586	20	1, 2, 7, 8, 9, 17, 19, 21, 22, 23, 28, 30, 31, 35, 39, 40, 50, 54, 55, 91
2	Osteoarthritis and cartilage	4.793	17	6, 12, 44, 46, 53, 59, 65, 66, 74, 75, 76, 77, 81, 83, 84, 94, 96
3	Annals of the rheumatic disease	16.102	9	36, 42, 48, 58, 62, 63, 64, 95, 97
4	Annals of internal medicine	21.317	5	15, 27, 37, 51, 99
5a	Lancet	60.392	4	33, 61, 88, 100
5b	The New England journal of medicine	74.699	4	3, 41, 67, 71
5c	The Journal of rheumatology	3.35	4	4, 16, 32, 69
5d	JAMA-journal of the American medical association	45.54	4	13, 26, 29, 34
6	The Journal of Clinical Investigation	11.864	3	5, 10, 14
7a	Clinical orthopedics and related research	4.329	2	47, 78
7b	American journal of sports medicine	5.81	2	72, 80
7c	Nature reviews rheumatology	16.625	2	85, 87
7d	The journal of bone and joint surgery	0	2	24, 57

Figure 2: The number of articles in different years.

Figure 3: (A) The type of articles. (B) The content of articles.

Type of Article and Theme of Study

The 100 top-cited articles covered several types of articles, including clinical research ($n = 38$), review ($n = 38$), guidelines and consensus ($n = 12$), basic science ($n = 10$) and

other types ($n = 2$) (Figure 3A). Clinical studies were divided into prospective study ($n = 19$), retrospective study ($n = 11$), randomized controlled trial (RCT) ($n = 7$) and case report ($n = 1$). The theme of these studies on OA mainly focused on treatment ($n = 25$), followed by pathophysiology ($n = 21$), etiology/harm ($n = 14$), epidemiology ($n = 14$), diagnosis ($n = 10$), prognosis ($n = 4$) and others (Figure 3B).

Discussion

OA was an age-related disease, and it was the highest incidence rate of osteoarthropathy worldwide, especially the OA of hip and knee joints, which were the main cause of global disability. It had a significant impact on individual well-being and increased the social and individual economic burden. Therefore, more researches were needed to guide the prevention, diagnosis, and treatment of OA. The purpose of this study was to analyze the 100 top-cited articles in the field of OA at home and abroad in the past 30 years, hoping to provide a valuable reference for further research on OA.

Although citations are not the only criterion for judging the importance of an article, it was usually used to identify very useful papers and regarded as a proxy to the academic value and influence of an article to a certain extent. The highest cited article, authored by Silverstein, was cited 2382 times. The reasons why it was quoted most frequently might be: (1) Its content was a hot topic in clinical practice; (2) Its type of study was a randomized controlled trial with the highest quality of evidence; (3) It was published in a journal with high impact factor; (4) It was published for 20 years, and has enough time to accumulate citations. Many factors were affecting the number of citations of articles, one of which was the impact factor of the published journals. The higher the impact factor of a journal, the more likely its articles would be concerned and cited. It was worth mentioning that Arthritis &

Rheumatism (renamed Arthritis & Rheumatology) contributed to most articles in this study. Although its impact factor was not the highest, it was the official journal of the American College of Rheumatology, and its impact factor ranked the top three in similar journals in rheumatism. Therefore, many target articles were published in this journal.

The main types of articles were clinical studies ($n = 38$) and reviews ($n = 38$). Unsurprisingly, the institution with the largest number of articles was Boston University in the United States. The United States had the largest number of cited articles in the field of OA, as well as in most medical fields.

The span of the publication date of these target articles was from Nov 1990 to Jul 2015. Most of the highly-cited articles ($n = 74$) were published after 2000. Taking a five-year time frame, we found that the five-year period from 2000 to 2004 saw the largest number of these target articles ($n = 34$, total impact factor = 528.696), followed by 2005–2009 ($n = 21$, total impact factor = 369.643), 1995 to 1999 ($n = 20$, total impact factor = 177.638), 2010 to 2014 ($n = 18$, total impact factor = 186.081), 1990–1994 ($n = 6$, total impact factor = 130.402) and after 2015 ($n = 1$, total impact factor = 60.392). It was not difficult to see that the total impact factor in different periods was closely related to the number of articles and the impact factor of each journal.

The theme of these studies on OA mainly focused on treatment ($n = 25$) and pathophysiology ($n = 21$). Secreted inflammatory molecules were among the critical mediators of the disturbed processes implicated in OA pathophysiology. Interleukin (IL)-1 beta and tumor necrosis factor (TNF), in particular, control the degeneration of the articular cartilage matrix.^[12] Treatment options included non-drug therapy, drug therapy, and surgical therapy. The treatments discussed in this article included cartilage protectant ($n = 5$), weight loss and exercise ($n = 3$), joint replacement ($n = 2$), and comprehensive therapy ($n = 15$). The treatment of knee and hip joint were mainly discussed. Joints nutritional supplements could be used in mild to moderate doses for patients to relieve pain and improve function.^[13] Cartilage protectant was mainly discussed with glucosamine sulfate. For people with body

mass index ≥ 28 kg/m², researches have shown that combining modest weight loss provided the best overall improvements in self-reported measures of function and pain and performance measures of mobility.^[14] For those patients with hip and knee OA who were not obtaining adequate pain relief and functional improvement with a combination of pharmacological and non-pharmacological treatments, there were five main surgical modalities: total joint replacements, unicompartmental knee replacement, osteotomy, and joint preserving surgical procedures; joint lavage and arthroscopic debridement in knee OA, and joint fusion as a salvage procedure when joint replacement had failed.^[15] It was worth noting that the treatment should be tailored to the specific needs of different patients. Many factors need to be taken into account, such as risk factors, location of structural damage, pain intensity, degree of dysfunction, patient's expectations, and so on.

It should be kept in mind that this study had some limitations. First, this study only searched articles on the web of science, neglecting the articles published in the printed version, which might omit some important articles. Second, the number of citations was sometimes different according to the citation database, such as the Web of Science and Google Scholar. Third, they were limited to English, and some important articles published in other languages might be omitted. Furthermore, there were also other potential elements. For example, time might affect the number of citations. The recent articles might have inadequate time to accumulate the number of citations, although total citation times were not obviously associated with the age of the article.^[16] Despite limitations, we believed this study could contribute to obtaining vital developments of OA and providing new insights into innovation in this field.

Conclusion

This study identified the top 100 most cited articles in OA in recent 30 years and analyzed their bibliometric characteristics, which may pave the way for further research. Most of the articles were published after 2000. But the latest articles may not be included in the top 100 cited articles, because recent studies did not have enough time to accumulate the number of citations.

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Conflict of Interest

The authors have declared no conflicts of interest.

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Author Contributions

Feng Yin and Qiuyu Yang wrote the manuscript; Chengsong He and Jie Chen revised the manuscript; All authors read and approved the final manuscript. Conceptualization: Feng Yin. Data curation: Feng Yin, Qiuyu Yang, Yue He, Lihui Peng, Zixia Zhao. Formal analysis: Feng Yin, Jie Chen. Funding acquisition: Jie Chen. Investigation: Feng Yin, Jie Chen. Methodology: Feng Yin, Qiuyu Yang, Yue He, Lihui Peng, Zixia Zhao, Chengsong He, Jie Chen. Resources: Jie Chen. Writing – original draft: Feng Yin, Qiuyu Yang, Jie Chen. Writing – review & editing: Feng Yin, Qiuyu Yang, Yue He, Lihui Peng, Zixia Zhao, Chengsong He, Jie Chen.

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