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Top-100 cited articles on headache disorders: A bibliometric analysis

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ABSTRACT

Objective: The purpose of this study was to identify and characterize the most-cited articles on headache disorders published in journals that have made key contributions in the field.
Patients and methods: We performed a search of journals and selected the top-100 cited articles by utilizing the Institute for Scientific Information database available under the banner of the Web of Science, which provides the most relevant bibliometric information on scientific articles published since 1950.
Results: The top-100 cited articles were published in 20 journals. The most frequently cited journal was *Neurology* (19 articles), and followed by *Cephalagia* (15 articles) and *Headache* (15 articles). Migraine was the most common topic subject (81 articles), and original articles predominated (91 articles). The topics of the classic articles had varied from decade to decade. The most common topic subject was epidemiology (37 articles), followed by pathophysiology (20 articles), treatment (18 articles), review (10 articles), neuroimaging (11 articles), genetics (3 articles), and diagnostic tools (2 articles).
Conclusion: The present study has produced a detailed list of the most-cited articles on headache disorders, which is the first such study in this field. This list makes it possible to recognize the classic articles on headache disorders as well as research trends and academic achievements in this field.

1. Introduction

Headache is one of the most common disorders of the nervous system, and it has several subtypes: primary headache such as tension-type headache (TTH), migraine, and cluster headache; secondary headache; and other headaches [1]. Headache has a high prevalence, with worldwide epidemiology studies having found the global prevalence rates of current headache, migraine, and TTH to be 47%, 10%, and 38%, respectively, with corresponding lifetime prevalence rates of 66%, 14%, and 46% [2]. Headache disorders are highly burdensome at both the individual and societal levels, with a substantial penalty in lost production [3], and hence they are important targets for public health interventions.

The Science Citations Index was initiated at the Institute for Scientific Information (ISI), which is now owned by the Thomson Corporation of Toronto. It maintains a systematic ongoing measurement of the citation counts for scientific journals [4]. The ISI database, via the Expanded version of the Science Citation Index and the Journal Citation Reports, contains more than 11,000 international journals and provides the complete bibliographical information of these indexed publications [4]. It is a multidisciplinary index to the scientific journal literature. The number of citations an article receives after publication is considered to reflect its impact on the scientific community [5–7]. Reviewing articles that are cited frequently can provide information about the dominant areas of a discipline, as well as indicate the growth of particular fields.

Several studies have analyzed the most-cited articles in various medical fields, including general surgery [8], anesthesiology [9], emergency medicine [10], plastic surgery [11], dermatology [12], obstetrics and gynecology [13], orthopedic surgery [14], critical-care medicine [15], and various aspects of neurology such as essential tremor [16], neuroimaging [17] and epilepsy [18]. However, to the best of our knowledge, no previous study has comprehensively analyzed the most-cited articles on headache disorders.

The purpose of this study was to identify and characterize the most-cited articles on headache disorders published in journals that have made key contributions in the field.

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2. Material and methods

We performed a citation analysis of headache disorders. Citation analysis is a bibliometric method that examines the frequency and patterns of citations in articles. The processing stream of citation analysis consisted of several stages as described below.

First, we performed a search of journals and selected the most-cited articles by utilizing the ISI database available under the banner of the Web of Science. Based on the Science Edition 2014 of Journal Citation Reports, journals covering the following 3 topics were included: 192 journals on "clinical neurology," 252 journals on "neuroscience," and 110 journals on "medicine, general & internal." Because an article that has been cited more than 100 times is usually considered a "classic," we retrieved all articles that were cited more than 100 times at the time of the search (February 2016) using the "cited reference search" facility of the Expanded version of the Science Citation Index of the ISI Web of Science for each included journal. Classic articles tend to represent historical landmarks in the evolution of a specific area.

Second, to identify headache disorders-related articles, we searched for the terms "headache," "migraine," and "cephalalgia" in the selected articles that have been cited more than 100 times.

Third, we identified and selected the top-100 cited articles related to headache disorders. We then manually reviewed the contents of these articles by examining characteristics such as the number of citations, ranking, authorship, article title, year of publication, publishing journal, publication type, and topic categories. The publication types were categorized into original article, case series, and systemic review, and the topic subjects were subtyped as epidemiology, review, pathophysiology, treatment, neuroimaging, genetics, and diagnostic tools. We excluded articles regarding guidelines because they were not research articles. When the authors of an article had more than one affiliation, the department, institution, and country of origin for the article were defined by the affiliation of the first author. Data are presented using descriptive statistics, and no tests of statistical significance were performed. This study did not need to be reviewed by an ethics committee because it performed a bibliometric analysis of existing published studies and did not involve any additional human subjects.

3. Results

Five hundred and thirty articles directly related to headache disorders and cited more than 100 times in the ISI database were retrieved. We selected the 100 most frequently cited articles for further analysis, and ranked them according to the number of citations (Table 1). The most- and least-cited articles were cited 1059 and 209 times, respectively, with 21 articles being cited 400 times.

The top-100 cited articles were published in 20 journals (Table 2). The most frequently cited journal was *Neurology* (19 articles), followed by *Headache* (16 articles), and *Cephalagia* (12 articles). About half of the articles (49 articles) were retrieved from these three journals.

Migraine was the most common topic subject (81 articles). There were three articles on trigeminal autonomic cephalalgias, and only one article regarding TTH was found. In addition, there was an article related with internal carotid and vertebral artery dissections, and an article about orthostatic headache with magnetic resonance imaging.

The top-100 cited articles originated from institutions in 12 countries, with the United States of America (USA) contributing 44 articles, followed by Denmark (16 articles), the United Kingdom (UK) (10 articles), and the Netherlands (8 articles) (Table 3).

Tables 4 and 5 list the top-ranked institutions and authors for the published headache-disorder citation classics associated with three or more articles. Eight institutions provided three or more most-cited articles. The institutions associated with the largest number of headache-disorder citation classics were Leiden University in the Netherlands (eight articles), followed by the University of Copenhagen in Denmark (seven articles) and Albert Einstein College of Medicine in the USA (seven articles). The first authors who appeared most frequently in the headache-disorder citation classics were Olesen J and Lipton RB, being the first authors of six articles each.

The publication decades are listed in Table 6, which indicates that 41 and 44 of the citation classics were published during the 2000s and 1990s, respectively. The earliest recorded article was published in 1960, and the most recent article was published in 2010. Regarding article types, 90 were original articles and 10 were systemic review articles, and there were no case series. The most common topic subject was epidemiology (37 articles), followed by pathophysiology (20 articles), treatment (18 articles), review (10 articles), neuroimaging (11 articles), genetics (3 articles), and diagnostic tools (2 articles) (Table 6). Most of the studies concerning epidemiology and diagnostic tools were conducted before 2000, whereas the researches about treatment and genetics were performed after 2000.

4. Discussion

This study has identified and characterized the top-100 cited articles on headache disorders. These citation classics may facilitate the identification of academic advances and provide a historical perspective on the scientific progress and emerging topics in a particular field [6,7]. The present study utilized the ISI database to identify the important works in the field of headache disorders.

A particularly interesting finding was migraine being the most common topic subject in the top-100 cited articles on headache disorders (81 articles). This might be due to most studies of headache disorders focusing on migraine, perhaps due to its high prevalence and disabling nature. The top-ranked article, which was authored by Lipton RB in 2001, was on migraine [19]. This article was cited 1059 times and it described the prevalence, sociodemographic profile, and the burden of migraine in the USA in 1999. This article reported on the American Migraine Study II, which found that the prevalence of migraine was 18.2% among females and 6.5% among males, and increased from an age of 12 years up to an age of about 40 years, after which it declined in both sexes. It also revealed that work or school productivity was reduced by at least 50% in 51% of the respondents. Thus, that article concluded that migraine was a highly prevalent headache disorder that has a substantial impact on both the individual and society. The reported study also compared results with the original American Migraine Study performed in 1989 as a population-based epidemiologic study employing identical methods as those in the American Migraine Study II, which was surprisingly the second most frequently cited article in the field of headache disorders [20], being cited 1050 times. These two articles could be most frequently cited because the reported studies successfully demonstrated how important headache disorders are for public health. The third most frequently cited article was also related to migraine [21]. It was a review article describing the epidemiology, pathophysiology, and treatment of migraine, and was cited 934 times.

There were three articles on trigeminal autonomic cephalalgias [22–24], two of which were specific to cluster headache [23,24]. Cluster headache is an uncommon form of primary headache compared with migraine or TTH, but it is an important neurologic problem due to it being associated with prolonged disabling and distressing episodic pain [23]. Bahra et al. prospectively studied the clinical and epidemiologic characteristics of a large population of patients with cluster headache [23]. They found that patients with cluster headache were equally likely to be prescribed antimigraine prophylaxis that had not been shown to be effective in the treatment of cluster headache despite there being existing effective prophylactic options. The other study investigated the pathophysiology of cluster headache using positron-emission tomography [24]. Activation in the hypothalamus was seen solely in the pain state of cluster headache, suggesting central nervous system dysfunction in the region of the hypothalamus as the main pathological mechanism underlying cluster headache.

Table 1
The top-100 cited articles on headache disorders.

Rank	First author	Journal	Title	Number of citations
1	Lipton RB	Headache 2001;41(7):646–657.	Prevalence and burden of migraine in the United States: Data from the American Migraine Study II.	1059
2	Stewart WF	JAMA 1992;267(1):64–69.	Prevalence of migraine headache in the United States. Relation to age, income, race, and other sociodemographic factors	1050
3	Goadsby PJ	N Engl J Med 2002;346(4):257–270.	Migraine – current understanding and treatment.	934
4	Goadsby PJ	Ann Neurol 1990;28(2):183–187.	Vasoactive peptide release in the extracerebral circulation of humans during migraine headache.	738
5	Sorge F	Cephalagia 1988;8(1):1–6.	Flunarizine in prophylaxis of childhood migraine. A double-blind, placebo-controlled, crossover study.	711
6	Stovner LJ	Cephalagia 2007;27(3):193–210.	The global burden of headache: A documentation of headache prevalence and disability worldwide.	701
7	Morley S	Pain 1999;80(1–2):1–13.	Systematic review and meta-analysis of randomized controlled trials of cognitive behaviour therapy and behaviour therapy for chronic pain in adults, excluding headache.	698
8	Lauritzen M	Brain 1994;117(Pt1):199–210.	Pathophysiology of the migraine aura. The spreading depression theory.	669
9	Lipton RB	Neurology 2007;68(5):343–349.	Migraine prevalence, disease burden, and the need for preventive therapy.	650
10	Olesen J	Ann Neurol 1981;9(4):344–352.	Focal hyperemia followed by spreading oligemia and impaired activation of rCBF in classic migraine.	625
11	Olesen J	N Engl J Med 2004;350(11):1104–1110.	Calcitonin gene-related peptide receptor antagonist BIBN 4096 BS for the acute treatment of migraine.	600
12	Olesen J	Cephalagia 2006;26(6):742–746.	New appendix criteria open for a broader concept of chronic migraine.	595
13	Goadsby PJ	Ann Neurol 1993;33(1):48–56.	The trigeminovascular system and migraine: Studies characterizing cerebrovascular and neuropeptide changes seen in humans and cats.	581
14	May A	Lancet 1998;5(1):60–66	Hypothalamic activation in cluster headache attacks.	580
15	Ferrari MD	Lancet 2001;22(8):633–658.	Oral triptans (serotonin 5-HT(1B/1D) agonists) in acute migraine treatment: A meta-analysis of 53 trials.	525
16	Burstein R	Ann Neurol 2000;47(5):614–624.	An association between migraine and cutaneous allodynia.	499
17	Kruit MC	JAMA 2004;291(4):427–434.	Migraine as a risk factor for subclinical brain lesions.	488
18	Hu XH	Arch Intern Med 1999;159(8):813–818	Burden of migraine in the United States: Disability and economic costs.	470
19	Goadsby PJ	Brain 1997;120(Pt1):193–209.	A review of paroxysmal hemicranias, SUNCT syndrome and other short-lasting headaches with autonomic feature, including new cases	464
20	Silberstein SD	Neurology 1996;47(4):871–875.	Classification of daily and near-daily headaches: Field trial of revised IHS criteria.	431
21	Burstein R	Brain 2000;123(Pt3):1703–1709.	The development of cutaneous allodynia during a migraine attack clinical evidence for the sequential recruitment of spinal and supraspinal nociceptive neurons in migraine.	409
22	Castillo J	Headache 1999;39(3):190–196.	Epidemiology of chronic daily headache in the general population.	398
22	Dichgans M	Lancet 2005;366(9483):371–377.	Mutation in the neuronal voltage-gated sodium channel SCN1A in familial hemiplegic migraine.	398
24	Lipton RB	Headache 2001;41(7):638–645.	Migraine diagnosis and treatment: Results from the American Migraine Study II	385
25	Scher AI	Headache 1998;38(7):497–506.	Prevalence of frequent headache in a population sample.	376
26	Woods RP	N Engl J Med 1994;331(25):1689–1692.	Brief report: Bilateral spreading cerebral hypoperfusion during spontaneous migraine headache.	370
27	Olesen J	Ann Neurol 1990;28(6):791–798.	Timing and topography of cerebral blood flow, aura, and headache during migraine attacks.	362
28	Goadsby PJ	Brain 1994;117(Pt3):427–434.	Human in vivo evidence for trigeminovascular activation in cluster headache. Neuropeptide changes and effects of acute attacks therapies.	344
29	Ferrari MD	Lancet 1998;351(9108):1043–1051.	Migraine	342
30	Lassen LH	Cephalalgia 2002;22(1):54–61.	CGRP may play a causative role in migraine.	338
31	Scher AI	Pain 2003;106(1–2):81–89.	Factors associated with the onset and remission of chronic daily headache in a population-based study.	336
32	Bahra A	Lancet 2001;357(9261):1016–107.	Brainstem activation specific to migraine headache.	335
33	Silberstein SD	Arch Neurol 2004;61(4):190–195.	Topiramate in migraine prevention: Results of a large controlled trial.	333
34	Lipton RB	Neurology 2002;58(6):885–894.	Migraine in the United States: Epidemiology and patterns of health care use.	331
35	Welch KM	Headache 2001;41(7):629–637.	Periaqueductal gray matter dysfunction in migraine: Cause or the burden of illness?	318
36	Friberg L	Lancet 1991;338(8758):13–17.	Migraine pain associated with middle cerebral artery dilatation: Reversal by sumatriptan.	313
37	Launer LJ	Neurology 1992;53(3):537–542.	The prevalence and characteristics of migraine in a population-based cohort: The GEM study.	309
38	Rasmussen BK	Cephalalgia 1992;12(4):221–228.	Migraine with aura and migraine without aura: An epidemiological study.	305
39	Rasmussen BK	Cephalalgia 1995;15(1):45–68.	Epidemiology of headache.	303
40	Burstein R	Ann Neurol 2004;55(1):19–26.	Defeating migraine pain with triptans: A race against the development of cutaneous allodynia.	301
41	Silberstein SD	Headache 2000;40(6):445–450.	Botulinum toxin type A as a migraine preventive treatment. For the BOTOX Migraine Clinical Research Group.	300
42	Siberstein SD	Headache 1994;34(1):1–7.	Classification of daily and near-daily headaches: Proposed revisions to the IHS criteria.	299
43	Mathew NT	Headache 1987;27(2):102–106.	Transformed or evolutive migraine.	298
44	Pietrobon D	Nat Rev Neurosci 2003;4(5):386–398.	Neurobiology of migraine.	296
45	Mathew NT	Headache 1982;22(2):66–68.	Transformation of episodic migraine into daily headache: Analysis of factors.	295
46	Edmeads J	Can J Neurol Sci 1993;20(2):131–137.	Impact of migraine and tension-type headache on life-style, consulting behaviour, and medication use: A Canadian population survey.	289
46	Anzola GP	Neurology 1999;52(8):1622–1625.	Potential source of cerebral embolism in migraine with aura: A transcranial Doppler study.	289
48	Linet MS	JAMA 1989;261(15):2211–2216.	An epidemiologic study of headache among adolescents and young adults.	287
49	Breslau N	Neurology 2003;60(8):1308–1312.	Comorbidity of migraine and depression: Investigating potential etiology and prognosis.	285
50	Ferrari MD	Cephalalgia 2002;22(8):633–658.	Triptans (serotonin, 5-HT1B/1D agonists) in migraine: Detailed results and methods of a meta-analysis of 53 trials.	283
50	Neuhauser H	Neurology 2001;56(4):436–441.	The interrelations of migraine, vertigo, and migrainous vertigo.	283
52	Cady RK	JAMA 1991;265(21):2831–2835.	Treatment of acute migraine with subcutaneous sumatriptan.	282

(continued on next page)

Table 1 *(continued)*

Rank	First author	Journal	Title	Number of citations
53	Ducros A	N Engl J Med 2001;345(1):17–24.	The clinical spectrum of familial hemiplegic migraine associated with mutations in a neuronal calcium channel.	280
54	Rasmussen BK	Pain 1993;53(1):65–72.	Migraine and tension-type headache in a general population: Precipitating factors, female hormones, sleep pattern and relation to lifestyle.	279
54	Kurth T	JAMA 2006;296(3):2832–2891.	Migraine and risk of cardiovascular disease in women.	279
56	Ho TW	Lancet 2008;72(9656):2115–2123.	Efficacy and tolerability of MK-0974 (telcagepant), a new oral antagonist of calcitonin gene-related peptide receptor, compared with zolmitriptan for acute migraine: A randomized, placebo-controlled, parallel-treatment trial.	273
57	Stang PE	Headache 1993;33(1):29–35.	Impact of migraine in the United States: Data from the National Health Interview Survey.	271
58	Ferrari MD	N Engl J Med 1991;325(5):316–321.	Treatment of migraine attacks with sumatriptan. The Subcutaneous Sumatriptan International Study Group.	265
58	Matharu MS	Brain 2004;127(Pt1):220–230.	Central neuromodulation in chronic migraine patients with suboccipital stimulators: A PET study.	265
60	Lauritzen M	Brain 1984;107(Pt2):447–461.	Regional cerebral blood flow during migraine attacks by Xenon-133 inhalation and emission tomography.	264
61	Lauritzen M	Ann Neurol 1983;13(6):633–641.	Changes in regional cerebral blood flow during the course of classic migraine attacks.	262
62	Ayata C	Ann Neurol 2006;59(4):652–661	Suppression of cortical spreading depression in migraine prophylaxis.	261
63	Ho TW	Neurology 2008;70(16):1304–1312	Randomized controlled trial of an oral CGRP receptor antagonist, MK-0974, in acute treatment of migraine.	258
64	Kayan A	Brain 1984;107(Pt4):1123–1142.	Neuro-otological manifestations of migraine.	252
65	Bendtsen L	Cephalalgia 2000;20(5):486–508.	Central sensitization in tension-type headache – possible pathophysiological mechanisms.	250
66	Breslau N	Neurology 2000;54(2):308–313.	Headache and major depression: Is the association specific to migraine?	248
66	Stewart WF	Neurology 1999;53(5):988–994.	An international study to assess reliability of the Migraine Disability Assessment (MIDAS) score.	248
68	May A	J Cereb Blood Flow Metab 1999;19(2):115–127.	The trigeminovascular system in humans: Pathophysiologic implications for primary headache syndromes of the neural influences on the cerebral circulation.	246
69	Wilmshurst PT	Lancet 2000;356(9242):1648–1651.	Effect on migraine of closure of cardiac right-to-left shunts to prevent recurrence of decompression illness or stroke or for hemodynamic reasons.	244
70	Osterhaus JT	Headache 1994;34(6):337–343.	Measuring the functional status and well-being of patients with migraine headache.	243
71	Stewart WF	Cephalalgia 1999;19(2):107–114.	Reliability of the migraine disability assessment score in a population-based sample of headache sufferers.	242
72	Mathew NT	Arch Neurol 1995;52(3):281–286.	Migraine prophylaxis with divalproex.	240
72	Scher AI	Neurology 2005;64(4):614–620.	Cardiovascular risk factors and migraine: The GEM population-based study.	240
74	Pryse-Phillips W	Can J Neurol Sci 1992;19(3):333–339.	A Canadian population survey on the clinical, epidemiologic and societal impact of migraine and tension-type headache.	235
74	Jull G	Spine 2002;27(17):1835–1843.	A randomized controlled trial of exercise and manipulative therapy for cervicogenic headache.	235
74	Vanmolkot KR	Ann Neurol 2003;54(3):360–366.	Novel mutations in the Na+, K+-ATPase pump gene ATP1A2 associated with familial hemiplegic migraine and benign familial infantile convulsions.	235
77	Henry P	Cephalalgia 1992;12(4):229–237.	A nationwide survey of migraine in France: Prevalence and clinical features in adults. GRIM.	234
78	SomervilleBW	Neurology 1972;22(4):355–365.	The role of estradiol withdrawal in the etiology of menstrual migraine.	233
79	Lipton RB	Neurology 2000;55(5):629–635.	Migraine, quality of life, and depression – A population-based case–control study.	231
80	Lipton RB	Headache 1998;35(2):87–96.	Medical consultation for migraine: Results from the American migraine study.	229
81	Silbert PL	Neurology 1995;45(8):1517–1522.	Headache and neck pain in spontaneous internal carotid and vertebral artery dissections.	228
82	Iversen HK	Pain 1989;38(1):17–24	Intravenous nitroglycerin as an experimental model of vascular headache. Basic characteristics.	226
82	Olesen J	Neuroreport 1993;4(8):1027–1030.	Nitric oxide supersensitivity: A possible molecular mechanism of migraine pain.	226
84	Durham PL	Headache 2004;44(1):35–42.	Regulation of calcitonin gene-related peptide secretion from trigeminal nerve cells by botulinum toxin type A: Implications for migraine therapy.	222
84	Aurora SK	Neurology 1998;50(4):1111–1114.	Transcranial magnetic stimulation confirms hyperexcitability of occipital cortex in migraine.	222
84	Diener HC	J Neurol 2004;251(8):943–950.	Topiramate in migraine prophylaxis – Results from a placebo-controlled trial with propranolol as an active control.	222
87	Diener HC	Cephalalgia 2010;30(7):804–814.	Onabotulinumtoxin A for treatment of chronic migraine: Results from the double-blind, randomized, placebo-controlled phase of the PREEMPT 2 trial.	221
87	Bigal ME	Headache 2008;48(8):1157–1168.	Acute migraine medications and evolution from episodic to chronic migraine: A longitudinal population-based study.	221
89	Sillanpää M.	Headache 1983;23(1):15–19.	Changes in the prevalence of migraine and other headaches during the first seven school years.	218
89	Stewart WF	Neurology 1996;47(1):52–59.	Variation in migraine prevalence by race.	218
91	Afridi SK	Brain 2005;128(Pt4):932–939.	A PET study exploring the laterality of brainstem activation in migraine using glyceryl trinitrate.	217
91	Welch KM	Neurol Clin 1990;8(4):817–828.	The concept of migraine as a state of central neuronal hyperexcitability.	217
93	Bahra A	Neurology 2002;58(3):354–361.	Cluster headache – A prospective clinical study with diagnostic implications.	216
94	Diener HC	Cephalalgia 2007;27(7):814–823.	Topiramate reduces headache days in chronic migraine: A randomized, double-blind, placebo-controlled study.	215
94	Carolei A	Lancet 1996;347(9014):1503–1506.	History of migraine and risk of cerebral ischaemia in young adults.	215
94	Terwindt GM	Neurology 2000;55(5):624–629.	The impact of migraine on quality of life in the general population – The GEM study.	215
97	KimBall RW	1960;10:107–111.	Effect of serotonin in migraine patients.	212
98	Mokri B	Neurology Mayo Clin Proc 1997;72(5):400–413.	Syndrome of orthostatic headaches and diffuse pachymeningeal gadolinium enhancement.	211
98	Dodick DW	Headache 2010;50(6):921–936.	OnabotulinumtoxinA for treatment of chronic migraine: Pooled results from the double-blind, randomized, placebo-controlled phases of the PREEMPT clinical program.	211
100	Jensen R	Pain 1993;52(2):193–199.	Muscle tenderness and pressure pain thresholds in headache. A population study.	209
100	Del Sette M	Cerebrovasc Dis 1998;8(6):327–330.	Migraine with aura and right-to-left shunt on transcranial Doppler: A case–control study.	209

Table 2
Journals with two or more of the top-100 cited articles on headache disorders.

Rank	Journal	Number of articles
1	Neurology	19
2	Headache	16
3	Cephalagia	12
4	Annals of Neurology	9
4	The Lancet	9
6	Brain	8
7	New England Journal of Medicine	5
7	Journal of the American Medical Association	5
7	Pain	5
10	Canadian Journal of Neurological Sciences	2
10	Archives of Neurology	2

Table 3
Countries of origin of the top-100 cited articles on headache disorders.

Rank	Country	Number of articles
1	USA	44
2	Denmark	16
3	UK	10
4	Netherlands	8
5	Germany	6
6	Australia	5
6	Italy	5
8	Canada	2
8	France	2
10	Finland	1
10	Norway	1
10	Spain	1

USA, The United States of America; UK, The United Kingdom.

Table 4
Institutions of origin of the first authors with three or more of the top-100 cited articles on headache disorders.

Rank	Institution	Number of articles
1	Leiden University Medical Centre, Netherlands	8
2	Glostrup Hospital, University of Copenhagen, Denmark	7
2	Albert Einstein College of Medicine, USA	7
4	Johns Hopkins University, USA	5
4	National Hospital for Neurology and Neurosurgery, UK	5
5	Gentofte Hospital, University of Copenhagen, Denmark	3
5	Henry Ford Hospital, USA	3
5	Prince Henry Prince Hospital, Australia	3
5	Rigshospitalet, Copenhagen, Denmark	3

USA, The United States of America; UK, The United Kingdom.

Only one article had a topic subject of TTH despite this being the most common type of headache disorder [2]. There has been little scientific interest in TTH, and that article investigated the mechanisms leading to myofascial tenderness and central pain mechanisms in patients with chronic TTH [25]. It was suggested that the main problem in chronic TTH was central sensitization at the level of the spinal dorsal horn/trigeminal nucleus due to prolonged nociceptive inputs from pericranial myofascial tissues.

The topics of the classic articles have varied from decade to decade, and we discovered some interesting trends in the topics over time. First, the most frequent topic subject of the top-100 cited articles was epidemiology. This is not consistent with the results from other citation analyses in various fields, which found frequent topic subjects such as basic research, treatment, or pathophysiology [8,9,11,15,16]. The high prevalence of headache disorders might result in more researchers being interested in its epidemiology. Second, 85 of the top-100 cited articles were published during the 1990s and 2000s. However, we found that most of the studies concerning epidemiology and diagnostic tools were conducted before 2000, whereas the researches about treatment and genetics were performed after 2000 (studies published before vs. after 2000 included 23 vs. 14 on epidemiology, 2 vs. 0 on diagnostic tools, 5 vs. 13 on treatment, and 0 vs. 3 studies on genetics). This trend may be attributed to the development of research techniques and changes in research interests in these fields.

Table 5
People indicated as first authors of three or more of the top-100 cited articles on headache disorders.

Rank	First author	Number of articles
1	Olesen J	6
1	Lipton RB	6
3	Goadsby PJ	5
4	Stewart WF	4
4	Ferrari MD	4
6	Silberstein SD	3
6	Lauritzen M	3
6	Burstein R	3
6	Scher AI	3
6	Rasmussen BK	3
6	Mathew NT	3
6	Diener HC	3

We found that about half of the top-100 cited articles originated from institutions in the USA, which is consistent with the overwhelming influence that the USA has on medical research, as also reported in articles on citation analyses of various specialties [8–11]. Institutions in the USA have made great contributions to the development of research in the field of headache disorders, which can be explained by the large size of the American scientific community and the enormous financial resources available to it. Moreover, it has been reported that authors in the USA usually prefer to publish in American journals and preferentially cite local papers [26]. However, the institutions associated with the largest number of headache-disorder citation classics were Leiden University in the Netherlands. Leiden University is the oldest university in the Netherlands, being founded in 1575 by William of Orange. Moreover, we found that none of the top-100 cited articles had first authors from Africa, Asia, or South America, despite recent increases in the number of headache-disorder articles originating from these countries in the field of neurology research [27]. This could be related to difficulties in research, publication, information access, and language barriers in these areas [28].

We attempted to eliminate any potential flaws in the citation analysis performed in this study, but there were inherent some limitations in analyses involving citation classics. There is obviously considerable debate regarding the value of citation rates. The main argument is that an article of greater value will be cited more often [29]. Even though using the total number of citations favors older publications and older journals [30], the use of citation rates is widely accepted as the best method of judging the merits of specific journals. A journal's impact factor is a measure of the frequency with which the average article in the journal has been cited during a given period of time. The impact factor is widely indicative of the importance of a given journal in its specific field of interest, and has emerged as a marker of the quality and rank of the journal [31]. Thus, although citation statistics have been frequently criticized, the analysis of citation rates can allow for the identification of advances in a specialty and may provide a historical perspective on its scientific progress.

5. Conclusion

The present study has provided a detailed list of the most-cited articles on headache disorders, which is the first such study in this field. This list makes it possible to recognize the classic articles on headache

Table 6
The number of publications of the top-100 cited articles on headache disorders according to topics.

Topic	Decade					
	1960–1969	1970–1979	1980–1989	1990–1999	2000–2009	2010–2016
Epidemiology			3	20	14	
Review	1			5	4	
Pathophysiology		1	7	4	8	
Treatment			1	4	11	2
Neuroimaging			1	6	4	
Genetics					3	
Diagnostic tools				2		
Total	1	1	12	41	44	2

disorders as well as research trends and academic achievements in this field.

Conflict of interest

None declared.

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