Narrative Review

Three Decades of Citation Classics: The Most Cited Articles in the Field of Physical Medicine and Rehabilitation

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With the American Academy of Physical Medicine and Rehabilitation recently celebrating its 75th anniversary, it is an opportune time to assess the impact and influence that physiatric articles and research have had on the field, as well as the greater scientific community. One useful metric of scientific impact is citation count, which is the most common method for analyzing the magnitude of scientific recognition of an individual article. This study presents 2 reading lists of influential physiatric academic journal articles drawn from the Web of Science index based on citation count. The first list contains the top 25 most-cited articles during the last 3 decades from the *American Journal of Physical Medicine and Rehabilitation*, the *Archives of Physical Medicine and Rehabilitation*, and *PM&R*. The second list contains the top 10 articles in 20 different physiatric topical areas. This topical list was generated via an expanded search without limitation of time span or journal. This allowed for the identification of influential physiatric articles not found in the field's 3 major publications from the United States. Although citation index is not a direct measure of quality or importance, it offers one form of quantitative assessment of scientific impact. This assessment contributes to the identification of trends, which illustrate the evolution of scope and focus of physiatry research. The lists of most-cited articles presented in this review can be used to provide historical context to physiatry's existing body of research, direct future evidence-based research efforts, and help guide educators as they select resident reading lists or journal club materials.

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As the Academy of Physical Medicine and Rehabilitation reaches its 75th year, it is important to assess the impact and influence that physiatric articles and research have had on the field, as well as the greater scientific community. Bibliometrics (methods for quantitatively analyzing scientific literature) provide techniques for such analysis. One useful metric is citation count, which is the most common method for analyzing the magnitude of scientific recognition of an individual article [1]. This should not be confused with slightly more complex algorithms that are also based on citation count—such as the impact factor and H-index—but used to analyze individual journals or authors, respectively.

In 1961, one of the founders of bibliometrics, Dr. Eugene Garfield, in an attempt to "track citations and understand trends in context," created the Science Citation Index [1]. This index grew into the Web of Science, which provides online access to the Science Citation Index as well as indices for other fields of Arts, Humanities, and Social Sciences via 7 online databases: Expanded, Social Sciences Citation Index, Arts & Humanities Citation Index, Index Chemicus, Current Chemical Reactions, Conference Proceedings Citation Index, and Book Citation Index. The Web of Science encompasses open-access journals and covers 10,000 of the highest-impact journals, with indexing coverage from the year 1900 to the present [2].

Two additional indices were released in the early 2000s: Google Scholar, a product of Google Inc., and Scopus, a product of Elsevier B.V. publishing groups. Google Scholar has yet to reveal the source content, indexing, relevance algorithms, or time period through which Scholar searches. It is a subset of the larger Google search index and includes

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websites, print publications, foreign translations, and books. The search also includes access to "gray literature," such as preprint archives, conference proceedings, institutional repositories, student handbooks, administrative notes, and links to the online collections of some academic libraries. Google Scholar is free, fast, and easy to access and lends itself to unconventional search topics not easily retrieved from more traditionally academic resources [3]. Scopus is available by subscription. It includes books, conference proceedings, web sites, reports, and patents from the US, European, and Japanese Patent Offices. Scopus is easy to navigate and comprehensive, including more journals but over fewer years [4].

All 3 indices have been compared in detail, with mixed results reported [5-7]. One well-described limitation to the Web of Science, compared with these other indices, is that it does not include citations from as many publication sources, which results in a substantial underestimation of citation counts. Regardless, the Web of Science remains the standard database for generating article lists by citation count analysis, likely because of historical reasons as well as its wide acceptance and recognition in the scientific community [8-11].

This article seeks to objectively identify the most influential and impactful articles from the field of physical medicine and rehabilitation. It is the authors' intention that the resulting list will prove useful for physiatrists and trainees by reminding us of our past, highlighting our contributions to the scientific community, and informing directions for future research. This article presents the 25 most-cited articles dating back 3 decades (1984-2013), from the 3 major physiatric journals from the United States (*Archives of Physical Medicine and Rehabilitation* [published since 1953], *American Journal of Physical Medicine and Rehabilitation* [published since 1922], and *PM&R* [published since 2009]). In addition, because many influential articles to the field of physiatry are not necessarily published in these 3 major publications, we also generated a list of articles within certain key physiatric topic areas ranked by citation count.

METHODS

Within the Web of Science, the 3 major physiatric journals were queried individually with time parameters of 1984 through 2013 for articles ranked by citation count. The years 1984 to 2013 were chosen because they span the last 3 decades of work and because the time frame also overlaps with the most recent compilation of top physiatric articles, which will be described in the Discussion section [12]. These 3 lists were then merged into a single list of the overall top 25 cited articles. This ranking list will be referred to as the Top 25 List. Similar lists were generated with Google Scholar and Elsevier Scopus.

Finally, 20 physiatric topic areas were chosen by a board-certified physiatrist (D.G.C.), based on review of the American Academy of Physical Medicine and Rehabilitation website on conditions and treatment [13], textbooks [14,15], and handbooks [16,17]. This list of topical keywords was presented to the various American Academy of Physical Medicine and Rehabilitation Membership Council representatives to ensure the keywords provided adequate representation of the major scopes of practice within the field. These topics were then searched via the Web of Science by title without parameters of time or journal and the top 10 cited articles in each category were compiled. This ranking list will be referred to as Top 200 List.

RESULTS

The 25 most cited articles from the last 30 years of publications for the *Archives of Physical Medicine and Rehabilitation*, *American Journal of Physical Medicine and Rehabilitation*, and *PM&R* (Top 25 List) are shown in Table 1. Twenty topical keywords were generated and are displayed in Table 2. The top 10 articles within these 20 topical keywords (Top 200 List) also were compiled and are shown in Table 3.

We highlight the following observations concerning the Top 25 List.

1. Investigators from the United States, United Kingdom, Canada, Denmark, and Taiwan were represented in the top 25 list.
2. Of the Top 25, 8 articles were published in the 1980s, 11 in the 1990s, and 6 in the 2000s.
3. There were several authors with multiple articles in the Top 25. Granger, Linacre, Wright, Jørgensen, Nakayama, Raaschou, and Olsen all had 3 articles; and Hamilton, and Heinemann, Cicerone, Dahlber, and Ottenbacher had 2 articles.
4. Among the authors, the following professional degrees were represented (and percentage at which they were represented): PhD (38%), MD (27%), OTR (11%), MD/PhD (6%), MS (5%), MA (5%), PT (3%), OTS (3%), and PhD/PT (2%).
5. Not one of the current Top 25 articles was written by an individual author.
6. The oldest article was published in 1984 and the most recent in 2005.

The following are interesting points regarding the Top 200 articles in 20 topical areas:

1. The oldest article was published in 1950, and the 2 most recent articles were printed in 2010.
2. Only 12 articles were from 1 of the 3 major physiatric journals.
3. Only 22 articles were printed before 1984.
4. Only one article from our Top 25 List from the 3 major physiatric journals was represented (Lum et al) [18].

Table 1. *Top 25 List: The most cited articles in the 3 major physical medicine and rehabilitation journals between 1984 and 2013*

Citation Rank	Number of Citations	Year Published	Title	Authors	Journal
1	739	1993	Technique to improve chronic motor deficit after stroke (19)	Taub E, Miller NE, Novack TA, et al.	*Arch*
2	675	1985	Grip and pinch strength: normative data for adults (20)	Mathiowetz V, Kashman N, Volland G, Weber K, Dowe M, Rogers S.	*Arch*
3	489	2001	Gait variability and fall risk in community-living older adults: a 1-year prospective study (21)	Hausdorff JM, Rios DA, Edelberg HK.	*Arch*
4	466	1986	Balance in elderly patients: the "get-up and go" test (22)	Mathias S, Nayak US, Isaacs B.	*Arch*
5	442	1994	The structure and stability of the Functional Independence Measure (23)	Linacre JM, Heinemann AW, Wright BD, Granger CV, Hamilton BB.	*Arch*
6	425	1992	Quantifying handicap: a new measure of long-term rehabilitation outcomes (24)	Whiteneck GG, Charlifue SW, Gerhart KA, Overholser JD, Richardson GN.	*Arch*
7	402	1993	A validation of the functional independence measurement and its performance among rehabilitation inpatients (25)	Dodds TA, Martin DP, Stolov WC, Deyo RA.	*Arch*
8	392	1992	Clinical and laboratory measures of postural balance in an elderly population (26)	Berg KO, Maki BE, Williams JI, Holliday PJ, Wood-Dauphinee SL.	*Arch*
9	382	2000	Evidence-based cognitive rehabilitation: Recommendations for clinical practice (27)	Cicerone KD, Dahlberg C, Kalmar K, et al.	*Arch*
10	365	2005	Evidence-based cognitive rehabilitation: Updated review of the literature from 1998 through 2002 (28)	Cicerone KD, Dahlberg C, Malec JF, et al.	*Arch*
11	332	1996	The reliability of the functional independence measure: A quantitative review (29)	Ottenbacher KJ, Hsu Y, Granger CV, Fiedler RC.	*Arch*
12	329	2002	Robot-assisted movement training compared with conventional therapy techniques for the rehabilitation of upper-limb motor function after stroke (30)	Lum PS, Burgar CG, Shor PC, Majmundar M, Van der Loos M.	*Arch*
13	320	1995	Outcome and time course of recovery in stroke. Part II: Time course of recovery. The Copenhagen Stroke Study (31)	Jørgensen HS, Nakayama H, Raaschou HO, Vive-Larsen J, Støier M, Olsen TS.	*Arch*
14	302	1999	Recent trends in mortality and causes of death among persons with spinal cord injury (32)	DeVivo MJ, Krause JS, Lammertse DP.	*Arch*
15	299	1989	Observations are always ordinal; measurements, however, must be interval (33)	Wright BD, Linacre JM.	*Arch*
16	288	2002	Exercise-induced muscle damage in humans (34)	Clarkson PM, Hubal MJ.	*Am*
17	283	1994	Recovery of upper extremity function in stroke patients: the Copenhagen Stroke Study (35)	Nakayama H, Jørgensen HS, Raaschou HO, Olsen TS.	*Arch*
18	274	2004	The effects of exercise training on elderly persons with cognitive impairment and dementia: a meta-analysis (36).	Heyn P, Abreu BC, Ottenbacher KJ.	*Arch*
19	274	1989	Spastic hypertonia: mechanisms and measurement (37)	Katz RT, Rymer WZ.	*Arch*
20	272	1984	Symptomatic fatigue in multiple sclerosis (38)	Freal JE, Kraft GH, Coryell JK.	*Arch*
21	260	1987	Development of a behavioral test of visuospatial neglect (39)	Wilson B, Cockburn J, Halligan P.	*Arch*
22	256	1993	Relationships between impairment and physical disability as measured by the functional independence measure (40)	Heinemann AW, Linacre JM, Wright BD, Hamilton BB, Granger C.	*Arch*

Table 1. *Continued*

Citation Rank	Number of Citations	Year Published	Title	Authors	Journal
23	254	1995	Recovery of walking function in stroke patients: the Copenhagen Stroke Study (41)	Jørgensen HS, Nakayama H, Raaschou HO, Olsen TS.	*Arch*
24	251	1989	Ordinal scales and foundations of misinference (42)	Merbitz C, Morris J, Grip JC.	*Arch*
25	244	1987	The Pain Disability Index: psychometric and validity data (43)	Tait RC, Pollard CA, Margolis RB, Duckro PN, Krause SJ.	*Arch*

Arch = Archives of Physical Medicine and Rehabilitation; Am = American Journal of Physical Medicine & Rehabilitation; PM&R = PM&R Journal.

5. Other journals with the most articles (with number of articles represented) were *Pain* (10), *Spine* (9), *Journal of the American Medical Association* (8), *New England Journal of Medicine* (7), *Arthritis & Rheumatism* (7), and *Neurology* (6).
6. The article with the highest citation count was "The American College of Rheumatology 1990 Criteria for the Classification of Fibromyalgia—Report of the Multicenter Criteria Committee" by Wolfe et al, with 4026 citations [19].

Table 2. *Major physical medicine and rehabilitation topics and keywords*

Topic	Keyword(s) for Article Title Search
Physical medicine and rehabilitation	Physical Medicine and Rehabilitation
Amputation	Amput*
Arthritis pain	Arthritis pain
Back pain	Back pain or lumbar pain
Cancer rehabilitation	Cancer rehab*
Cardiac rehabilitation	Cardiac rehab*
Electrodiagnosis	Electrodiagnos* or Electromyography or Nerve Conduction Stud*
Fibromyalgia	Fibromyalgia
Geriatric rehabilitation	Geriatric rehab*
Neck pain	Neck pain or cervical pain
Osteoporosis rehabilitation	Osteoporosis rehab*
Post-polio syndrome	Post-polio* syndrome
Pediatric rehabilitation	Pedia* rehab*
Pressure ulcers	Pressure ulcer* or pressure sore or pressure wound
Spinal injury	Spin* injury
Sports injury	Sport* injury
Stroke rehabilitation	Stroke Rehab*
Traumatic brain injury	Traumatic Brain injury
Wheelchairs	Wheelchair*
Work injury	Work injury or Job injury or occupational injury

*Multicharacter wild card used to replace characters in a word to broaden search results.

DISCUSSION

With this research, our goal was to identify the most influential or impactful research articles of the last 3 decades. Ascribing significance to an individual article within a large body of work is inherently difficult. We chose to generate a list of articles by using quantitative, bibliometric data. A citation index was used as the proxy for important research.

The result was 2 lists of article rankings. The first list was the top 25 most-citied articles published in the 3 major physiatric journals from US journals during the last 30 years. Knowing that many key physiatric articles are published in journals other than the 3 major physiatric journals, a second list of the top 200 most-cited articles from all journals within 20 physiatric topical areas was generated.

The Top 25 List revealed interesting trends. Each decade, apart from the present, was well represented in the list. We observed a progression from validation of measures and scales to descriptive studies in the first third of the 30-year period; more validation and emergence of large prospective trials in the middle third; and prospective studies, reviews, and meta-analyses in the latter third. These findings suggest that the field is concentrating less on validating measures and more on novel interventions and the establishment of best practices. Given the mounting pressures on all providers to prove efficacy of treatment for reimbursement in today's health care environment, as a field, we may need to re-emphasize validation of measures and scales.

From the Top 200 List, we see a large representation of journals (99 different journals in total). In addition, only one article from the Top 25 List, "Robot-assisted movement training compared with conventional therapy techniques for the rehabilitation of upper-limb motor function after stroke" by Lum et al [18], is represented in the Top 200 list. This finding confirms our observation that many influential articles on physiatric topics are published outside of the 3 major physiatric journals and likely indicates that many authors prefer to submit for publication to subspecialty physiatry journals first.

In addition, there were several articles from one of the 3 major physiatric journals that were included in the Top

Table 3. *Top 200 List: The most-cited references in major physical medicine and rehabilitation topical areas*

Physical medicine and rehabilitation	England JD, Gronseth GS, Franklin G, et al. Distal symmetric polyneuropathy: A definition for clinical research - Report of the American Academy of Neurology, the American Association of Electrodiagnostic Medicine, and the American Academy of Physical Medicine and Rehabilitation. Neurology 2005;64:199-207.
	Jablecki CK, Andary MT, Floeter MK, et al. Practice parameter: Electrodiagnostic studies in carpal tunnel syndrome—Report of the American Association of Electrodiagnostic Medicine, American Academy of Neurology, and the American Academy of Physical Medicine and Rehabilitation. Neurology 2002;58: 1589-1592.
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	England JD, Gronseth GS, Franklin G, et al. Practice Parameter: Evaluation of distal symmetric polyneuropathy: Role of autonomic testing, nerve biopsy, and skin biopsy (an evidence-based review) Report of the American Academy of Neurology, American Association of Neuromuscular and Electrodiagnostic Medicine, and American Academy of Physical Medicine and Rehabilitation. Neurology 2009;72:177-184.
	Stucki G, Melvin J. The international classification of functioning, disability and health: A unifying model for the conceptual description of physical and rehabilitation medicine. J Rehabil Med 2007;39:286-292.
	Haigh R, Tennant A, Biering-Sorensen F, et al. The use of outcome measures in physical medicine and rehabilitation within Europe. J Rehabil Med 2001;33:273-278.
	Needham DM, Korupolu R, Zanni JM, et al. Early physical medicine and rehabilitation for patients with acute respiratory failure: A quality improvement project. Arch Phys Med Rehabil 2010;91:536-542.
	Kucukdeveci AA, Yavuzer G, Tennant A, Suldur N, Sonel B, Arasil T. Adaptation of the modified Barthel Index for use in physical medicine and rehabilitation in Turkey. Scand J Rehabil Med 2000;32:87-92.
	England JD, Gronsethd GS, Franklin G, et al. Practice Parameter: Evaluation of distal symmetric polyneuropathy: Role of laboratory and genetic testing (an evidence-based review) Report of the American Academy of Neurology, American Association of Neuromuscular and Electrodiagnostic Medicine, and American Academy of Physical Medicine and Rehabilitation. Neurology 2009;72:185-192.
	Williams JA, Imamura M, Fregni F. Updates on the use of non-invasive brain stimulation in physical and rehabilitation medicine. J Rehabil Med 2009;41:305-311.
Amputation prosthetics	Flor H, Elbert T, Knecht S, et al. Phantom-limb pain as a perceptual correlate of cortical reorganization following arm amputation. Nature 1995;375:482–484.
	Merzenich M, Nelson R, Stryker M, Cynader M, Schoppmann A, Zook J. Somatosensory cortical map changes following digit amputation in adult monkeys. J Comp Neurol 1984;224:591–605.
	Pecoraro R, Reiber G, Burgess E. Pathways to diabetic limb amputation - basis for prevention. Diabetes Care 1990;13:513-521.
	Rosenberg S, Tepper J, Glatstein E, et al. The treatment of soft-tissue sarcomas of the extremities—prospective randomized evaluations of (1) limb-sparing surgery plus radiation-therapy compared with amputation and (2) the role of adjuvant chemotherapy. Ann Surg 1982;196:305-315.
	Waters R, Perry J, Antonelli D, Hislop H. Energy cost of walking of amputees—influence of level of amputation. J Bone Joint Surg-Am Vol 1976;58:42-46.
	Most R, Sinnock P. The epidemiology of lower-extremity amputations in diabetic individuals. Diabetes Care 1983;6:87-91.
	Cohen L, Bandinelli S, Findley T, Hallett M. Motor reorganization after upper limb amputation in man—a study with focal magnetic stimulation. Brain 1991;114:615–627.
	Bach S, Noreng M, Tjellden N. Phantom limb pain in amputees during the 1st 12 months following limb amputation, after preoperative lumbar epidural blockade. Pain 1988;33:297–301.
	Cortes E, Holland J, Wang J, et al. Amputation and adriamycin in primary osteosarcoma. N Engl J Med 1974;291:998-1000.
	Bild D, Selby J, Sinnock P, Browner W, Braveman P, Showstack J. Lower-extremity amputation in people with diabetes—epidemiology and prevention. Diabetes Care 1989;12:24-31.
Arthritis pain	Keefe F, Brown G, Wallston K, Caldwell D. Coping with rheumatoid-arthritis pain—catastrophizing as a maladaptive strategy. Pain 1989;37:51-56.
	Varni J, Thompson K, Hanson V. The Varni Thompson Pediatric Pain Questionnaire .1. Chronic Musculoskeletal Pain in Juvenile Rheumatoid-Arthritis. Pain 1987;28:27-38.
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	Summers M, Haley W, Reveille J, Alarcon G. Radiographic assessment and psychologic variables as predictors of pain and functional impairment in osteo-arthritis of the knee or hip. Arthritis Rheum. 1988;31:204-209.
	Ferraz M, Quaresma M, Aquino L, Atra E, Tugwell P, Goldsmith C. Reliability of pain scales in the assessment of literate and illiterate patients with rheumatoid-arthritis. J Rheumatol 1990;17:1022-1024.
	Brown G, Nicassio P, Wallston K. Pain coping strategies and depression in rheumatoid arthritis. J Consult Clin Psychol 1989;57:652-657.
	Flor H, Turk D. Chronic back pain and rheumatoid-arthritis—predicting pain and disability from cognitive variables. J Behav Med 1988;11:251-265.

Table 3. *Continued*

	Clemett D, Goa KL. Celecoxib—A review of its use in osteoarthritis, rheumatoid arthritis and acute pain. Drugs 2000;59:957-980.
	Bradley L, Young L, Anderson K, et al. Effects of psychological therapy on pain behavior of rheumatoid-arthritis patients—treatment outcome and 6-month follow-up. Arthritis Rheum 1987;30:1105-1114.
	Affleck G, Tennen H, Urrows S, Higgins P. Neuroticism and the pain mood relation in rheumatoid-arthritis—insights from a prospective daily study. J Consult Clin Psychol 1992;60:119-126.
Back pain	Roland M, Morris R. A study of the natural-history of back pain .1. Development of a reliable and sensitive measure of disability in low-back-pain. Spine 1983;8:141-144.
	Rosenstiel A, Keefe F. The use of coping strategies in chronic low-back-pain patients—relationship to patient characteristics and current adjustment. Pain 1983;17:33-44.
	Waddell G, Newton M, Henderson I, Somerville D, Main C. A fear-avoidance beliefs questionnaire (FABQ) and the role of fear-avoidance beliefs in chronic low-back-pain and disability. Pain 1993;52:157-168.
	Jensen M, Brantzawadzki M, Obuchowski N, Modic M, Malkasian D, Ross J. Magnetic-resonance-imaging of the lumbar spine in people without back pain. N Engl J Med 1994;331:69-73.
	Vlaeyen J, Kolesnijders A, Boeren R, Vaneek H. Fear of movement (re)injury in chronic low-back-pain and its relation to behavioral performance. Pain 1995;62:363-372.
	Andersson GBJ. Epidemiological features of chronic low-back pain. Lancet 1999;354:581-585.
	Waddell G. A new clinical model for the treatment of low-back-pain. Spine 1987;12:632-644.
	Linton SJ. A review of psychological risk factors in back and neck pain. Spine 2000;25:1148-1156.
	Crombez G, Vlaeyen JWS, Heuts P, Lysens R. Pain-related fear is more disabling than pain itself: Evidence on the role of pain-related fear in chronic back pain disability. Pain 1999;80:329-339.
	Deyo RA, Battie M, Beurskens A, et al. Outcome measures for low back pain research—A proposal for standardized use. Spine 1998;23:2003-2013.
Electrodiagnosis	De Luca CJ. The use of surface electromyography in biomechanics. J Appl Biomech 1997;13:135-163.
	Day B, Dressler D, Denoordhout A, et al. Electric and magnetic stimulation of human motor cortex—Surface EMG and single motor unit responses. J Physiol 1989;412:449-473.
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	Hallett M, Shahani B, Young R. EMG analysis of stereotyped voluntary movements in man. J Neurol Neurosurg Psychiatry 1975;38:1154−1162.
	Hakkinen K, Kallinen M, Izquierdo M, et al. Changes in agonist-antagonist EMG, muscle CSA, and force during strength training in middle-aged and older people. J Appl Physiol 1998;84:1341−1349.
Cancer rehabilitation	Schag C, Ganz P, Heinrich R. Cancer Rehabilitation Evaluation System - Short Form (CARES-SF)—a cancer-specific rehabilitation and quality-of-life instrument. Cancer 1991;68:1406-1413.
	Dimeo FC, Tilmann MHM, Bertz H, Kanz L, Mertelsmann R, Keul J. Aerobic exercise in the rehabilitation of cancer patients after high dose chemotherapy and autologous peripheral stem cell transplantation. Cancer 1997;79:1717-1722.
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	Berglund G, Bolund C, Gustafsson U, Sjoden P. One-year follow-up of the starting-again group rehabilitation program for cancer patients. Eur J Cancer 1994;30A:1744−1751.

Table 3. *Continued*

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	Harter M, Reuter K, Aschenbrenner A, et al. Psychiatric disorders and associated factors in cancer: Results of an interview study with patients in inpatient, rehabilitation and outpatient treatment. Eur J Cancer 2001;37: 1385-1393.
Cardiac rehabilitation	Oldridge N, Guyatt G, Fischer M, Rimm A. Cardiac rehabilitation after myocardial-infarction—combined experience. JAMA 1988;260:945-950.
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Work injury	Leigh JP, Markowitz SB, Fahs M, Shin C, Landrigan PJ. Occupational injury and illness in the United States—Estimates of costs, morbidity, and mortality. Arch Intern Med 1997;157:1557-1568.
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200 list but not represented in the Top 25 list. This was because division of subspecialties by topical keyword search allowed some articles with lower citation counts to be represented. Finally, only 22 articles in the list of 200 Major physiatric topic areas were published earlier than 30 years ago, which represents the time restriction we placed on the Top 25 List. This finding suggests an emergence of more recognized and influential articles on physiatric topics and possibly a trend toward more emphasis on conducting evidence-based research in physiatric scholarship. All and all, the Top 200 List reveals the diverse topical scope of practice of physiatry.

It cannot be overstated that citation counts are not a direct measure of quality or importance; rather, citation analysis provides a quantitative measure of scientific recognition [1,10]. One potential bias to this metric is that older

articles have the advantage of time to accumulate citations, whereas younger articles may not have a citation count that adequately reflects their potential impact. This is likely the reason why our lists do not contain any articles published after 2010. Citation analysis can also falsely elevate the importance of review articles or studies that describe new techniques. A high citation count can also occur when articles make extensive claims or broach a highly controversial topic [8].

The use of citation index is not a new approach to evaluating physiatric literature. Almost 30 years ago, Jack D. Key used this strategy to publish "Citation Classics," where he identified 14 of the most-cited articles exclusively from one journal [12]. Interestingly enough, when Dr. Key performed his initial citation count analysis, every single article had been from US investigators. The current Top 25 List represents authors from 5 different countries. In addition, many of the articles in the Top 25 List from 30 years ago had single authors. Our Top 25 List does not have a single article with only one author. Finally, not one of the articles from Dr. Key's original list is currently in the Top 25 List, which is yet another indication that physiatric research is accelerating and that the quantity of impactful studies produced has increased.

Additional studies that attempt to compile particularly impactful physiatric literature exist. More recently, Furlan and Fehlings [11] used citation counts to compile a list of influential articles, although their search scope was limited exclusively to the area of traumatic spinal cord injury. Other lists of physiatric articles have been compiled using subjective methodologies. Francisco et al and more recently, Moroz et al used expert panel consensus to generate the "Essential Articles in Physical Medicine and Rehabilitation Training" (1980-2003 and 2004-2010 update, respectively) [20,21]. These lists have been very valuable, particularly in rehabilitation education.

LIMITATIONS

Although some might argue that the use of a keyword search to identify articles is less precise and dependent on search engine algorithms, this method has been the standard for many citation count compilations [9-11,22]. It also allows researchers to create lists of top articles without introducing subjective analytic techniques. Slight alterations in keywords and the use of wild-card characters did not appreciably change search results among the top articles in each subject area.

Another critique of keyword searches is that they can be broad or vague, particularly for searches in topical areas with large scopes of practice. For example, pediatric rehabilitation may have generated a more pointed list of articles if it were further subdivided by using search terms such as "cerebral palsy" or "spasticity." However, the purpose of this article was not to delve into an exhaustive list of articles within all facets of physiatry but rather to provide a general overview of key topic areas.

Another methodologic limitation with regard to keyword searching was the shortcomings within the Web of Science search engine. We were required to search key terms under title, not under topic, because queries under topic often generated lists of articles that were unrelated to the search term. This invariably excluded some worthy articles that did not contain the topical keyword in the title.

The 20 topic areas represented core subjects that a physiatrist might reasonably be expected to recognize. Despite our best efforts to provide a completely objective analysis, it was difficult to develop a methodology without some element of subjectivity to determine these 20 topical areas. To limit the amount of bias within this subjective influence, we attempted to provide a subanalysis by soliciting input from the Academy of Physical Medicine and Rehabilitation Membership Councils. Of note, these topics were largely a product of textbooks and the Web of Science, which as discussed previously does not index citations from book sources. This may represent a limitation because the topics might not be equally represented in the published journal literature. The method seems reasonable, however, and the end result useful.

The goal was to identify further articles of interest more specific to the core subjects that were excluded from the initial Top 25 List. For instance, articles about "electrodiagnosis" or "postpolio syndrome," which most physiatrists would consider important areas of core competency, did not appear in the Top 25 List. The use of time parameters for selecting published works had a major influence on the articles that were selected. The years 1984 to 2013 were chosen because they span the last 3 decades of work. This time frame also overlaps with Dr. Key's search time span parameters in his Citation Classics from the 1980s and thus represents a continuum from his work [12]. An attempt was made to strike a balance between time parameters resulting in a list of historic articles that had gained large citation counts by attrition but lacked relevancy to modern practice and time parameters that would result in a list with no historical context. By using a 30-year time span parameter, we were able to achieve a finalized list that has a balanced representation of works from the 1980s, 1990s, and 2000s and demonstrates the progress of physiatric literature over three decades. As mentioned previously, although no such time parameters were enforced on the Top 200 Topical list, the fact that only 10% of the articles are more than 30 years old demonstrates the burgeoning of new impactful literature within the field.

In general, Google Scholar and Scopus provide slightly greater citation counts than the Web of Science. Despite differences in the absolute value of citations per article, however, our research demonstrated very little change to the overall ranking of articles. Also, we chose the Web of Science because it has been established as the predominate index

used in citation analysis studies, likely because it was the first index and remains the most prominent.

CONCLUSION

By examining physiatry's top cited articles, it becomes apparent how scientific discovery over the years has shaped the field and how new topics have emerged. The progression of physiatric literature from studies of validation of measures and scales to randomized trials testing novel therapeutic approaches is evident. There has clearly been an increased emphasis and interest in evidence-based research in the field as older articles, which would be expected to have accumulated more citations than newer articles, represent a much smaller portion of our rank lists than might be expected. It is also clear that there has been a shift to multiauthor collaborative projects and more representation from international investigators. These trends illustrate the evolution of scope and focus of physiatric research. As the Academy passes its 75th anniversary this compilation of 3 decades of citation classics serves as a reminder of past achievements, a tool for training current physiatrists, and a guide for future research.

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