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Bibliometric analysis of highly cited publications in health policy and services

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# Equal contribution

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The present study is to identify and analyse the characteristics of the highly cited articles in Web of Science category of health policy and services, within the publication year from 1923 to 2017 based on Social Science Citation Index. Highly cited articles that have been cited 100 times or more from Web of Science Core Collection since their publication year to the end of 2017 were analyzed. Publication year, authors, institutions, countries, journals, and citation life cycles were used to evaluate the publication performance of the highly cited articles. Four citation indicators were applied to evaluate highly cited articles. Six publication indicators were also used to compare performance of countries and institutions. A publication performance indicator, the *Y*-index, was applied to assess publication potential and the characteristics of authors. A relationship between number of articles in each year and their citations per publication by years was proposed for distribution of highly cited articles. Results showed that highly cited articles published in journals with not only higher journal impact factor but also lower one. The US and Harvard University ranked top in six publication indicators respectively. Y-index results showed that J.H. Hibbard had highly cited articles publication potential. In addition, each of the high impact classic articles in 2017 were summarized.

Keywords: *Web of Science, SSCI, Health policy and services, Highly cited, Y-index*

1. Introduction

There is a long history of health policy and services research. There were 79 journals listed in the Web of Science

category of health policy and services in Journal Citation Reports (JCR) in 2017. Numbers of bibliometric analysis using Social Science Citation Index (SSCI) in the category of health policy and services were published (Borgman and Rice, 1992; Moed et al., 1995; Brown et al., 2017). The first bibliometric study in category of health policy and services was published by Dame and Wolinsky (1993) titled "Rating journals in health care administration: the use of bibliometric measures" which contributed to the evaluation of university faculty performance by focusing on journal rating with bibliometric approach.

Citation offers an objective measure approach to the scientific literature and provides an objective methodology for evaluating as ranking journals or articles (Garfield, 1974; Kulkarni et al., 2009). The citations of publications were frequently used as an indicator for evaluating scientific performance (Garfield, 1979; Ho, 2012). Due to the neutral characteristic of citation data, the proper analysis and interpretation of citation data are a valuable quantitative method in the science and technology assessment process (Garfield, 1972; Oppenheim, 1997). Publications with high citations, such as equal to or more than 100 citations, are labelled as "highly cited publications" (Ho, 2014a). Various researchers have identified and investigated highly cited publications (Fu and Ho, 2016; Mo et al., 2018). Highly cited publications represent the most substantial breakthrough in specific research categories, which usually provide valuable insights which are inspiring the researchers in the fields over time (Garfield, 1979; Ho, 2012).

The articles has analysed in the highly cited publications in the Web of Science category of health policy and services in Social Science Citation Index (SSCI). All the publications with at least 100 citations were identified and analysed from the Web of Science Core Collection. We inquired the characteristics including publication year, journals, institutions, countries, authors, life citation cycles, and other attributes of these highly cited publications. This aim and meaning of the study will play the role as a beacon, enabling medical and health care practitioners to have the key index searching and understanding the whole map development with health policy and service. It also assists in sorting out important indicators and classic researches on the health policy and service, linking institutional care and non-institutional care healthcare system. The most important thing with this research will give practitioners in health care system to design and redesign the health policy and service with continuous diligence and quality improvement.

2. Methodology

The data used in this study were retrieved from the online version of Social Science Citation Index (SSCI) the Clarivate Analytics (formerly known as the Thomson Reuters and the Institute for Scientific Information) Web of Science Core Collection database. According to Journal Citation Reports (JCR) of 2017, it indexes 3,312 journals with citation references across 57 Web of Science categories in SSCI. Among them, 79 journals were listed in the Web of Science category of health policy and services in 2017. To investigate the citations received by the highly cited articles, four citation indicators were applied:

C_0: the number of citations from the Web of Science Core Collection in publication year (Ho and Kahn, 2014).

C_{year}: the number of citations in a particular year. C_{2017} means the number of publications in 2017 (Ho, 2012).

TC_{year}: the total number citations since publication to the end of the most recent year. In this study this is 2017 (TC_{2017}) (Wang et al., 2011, Chuang et al., 2011).

CPP_{year}: citations per publication ($CPP_{2017} = TC_{2017}/TP$) (Ho, 2012; Fu and Ho, 2018).

$TC_{year} \geq 100$ was used to retrieve the highly cited articles (Ho, 2014a, Fu and Ho, 2018). A total of 1,927 highly cited articles with $TC_{2017} \geq 100$ were found in the Web of Science category of health policy and services. We downloaded full records and citation data of all included articles and analysed them by Microsoft Excel 2016 (Li and Ho, 2008; Ho and Fu, 2016). The impact factor (IF_{2017}) of a journal was determined for each article as reported in the Journal Citation Reports (JCR) 2017.

Affiliations of authors in England, Scotland, Northern Ireland, and Wales were regrouped as one group by the United Kingdom (UK) (Chiu and Ho, 2005). Hong Kong before 1997 were included under the heading of China (Fu and Ho, 2013).

3. Results and Discussion

Document type of articles represented whole research ideas and results, articles were used for analysis (Ho et al., 2010). A total of 1,927 highly cited articles with $TC_{2017} \geq 100$ were found in Web of Science category of health policy and services.

3.1 *Characteristics of publication outputs*

Recently, a relationship between number of articles in each year (TP) and their citations per publication ($CPP_{year} = TC_{year}/TP$) by years in medical related topics for example, dengue (Ho et al., 2016) and Ebola (Pouris and Ho, 2016) as well as highly cited articles in research fields (Hsu and Ho, 2014; Brown et al., 2017) was proposed as a figure. Figure 1 shows the distribution of the 1,927 highly cited articles in Web of Science category of health policy and services and their citations per publication ($CPP_{2017} = TC_{2017}/TP$) by year. The earliest highly cited article was published in *Medical Care* in 1967 (Follette and Cummings, 1967). The most recent highly cited article was published in 2016 in *Journal of Health Economics* with TC_{2017} of 152 and C_{2017} of 109 by DiMasi et al. (2016) from USA. The annual number of articles fluctuated from one in 1967 to 22 in 1990 and then had sharply increasing to a peak with 129 articles in 2005. A total of 1,001 highly cited articles (52% of 1,927 articles) had no citations in the publication year ($C_0 = 0$). Although with an increasing number of journals in SSCI, articles have had higher citations in the publication year (C_0) in recent years (Ho and Kahn, 2014). Furthermore, among the top 100 C_0 articles, only 14% and 19% of them were among the top 100 TC_{2017} and C_{2017} articles respectively. Among the top 100 TC_{2017} articles, 64% of them were among the top 100 C_{2017} articles.

3.2 *Journals*

A total of 79 journals were listed in the Web of Science category of health policy and services in 2017. The 1,927 highly cited articles were published in 32 of these journals, and in 30 other health policy and services journals that were no longer tracked by Web of Science category of health policy and services in 2017. Table 1 shows the top 10 productive journals with more than 40 highly cited articles. Only three journals of the top six productive journals with $TP > 100$ ranked top ten in the Web of Science category of health policy. *Medical Care* published the largest number of highly cited articles with 474 articles (25% of 1,927 articles), followed by *Health Affairs* with 238, while their IF_{2017} were 3.338 (rank 7th of 79 journals) and 4.843 (4/79) respectively. *Medical Care* also ranked top in CPP_{2017} with 310. Figure 2 is a scatter plot (Hsieh et al., 2004) between number of highly cited articles and IF_{2017} – while there appeared no linear relationship between the two variables, all journals with more than one highly cited articles had an IF_{2017}. Only four highly cited articles were published in *BMJ Quality & Safety* which had the highest IF_{2017} of 7.226, ranked top in the Web of Science category of health policy and services in 2017. Similarly, there is no any highly cited articles published in *Journal of Patient Safety* ($IF_{2017} = 2.683$), ranked 10th. However 14 highly cited articles were published in *Inquiry-the Journal of Health Care Organization Provision and Financing* with the lowest journal impact ($IF_{2017} = 0.574$; ranked 77th).

3.3 *Countries*

Of the 1,898 highly cited articles with author information in Web of Science from across 54 countries, 1,620 articles (85% of 1,898 articles) were independent articles by a single country across 24 different countries; while, 278 (15%) articles were internationally collaborative articles from 53 different countries. Table 2 listed the top 12 countries ($TP \geq 20$) with six publication indicators: total number of articles (*TP*), single country articles (*IP*), internationally collaborative articles (*CP*), first-author articles (*FP*), corresponding-author articles (*RP*), and single-author articles (*SP*) (Ho and Kahn, 2014). Two American countries, nine European countries, and one in Australia were part of the top 12 publication ranking list. South Africa ranked 14th with 16 articles and China ranked 17th with 10 articles. USA had extremely high percentage in all six indicators followed distantly by the UK.

3.4 *Institutions*

With regard to institutions, 591 highly cited articles (31% of 1,898 articles) were of single institution whereas 1,313 articles (69%) were inter-institutionally collaborative. Table 3 demonstrates the characteristics of the top 10 institutions with at least 55 highly cited articles. Top 13 institutions were based in USA. McMaster University in Canada ranked 14th with 39 highly cited articles. Harvard University took the leading position for all publication indicators followed distantly by others. University of Michigan also published the most independent articles with 20 (3.4% of 591 inter-institutionally collaborative articles). University of California Los Angeles published 87 single institutional articles (ranked 2nd, 6.6% of 591 single institutional articles). Johns Hopkins University published 44 first-au-

thor articles (ranked 2nd, 2.3% of 1,898 first-author articles). University of California San Francisco published 39 corresponding-author articles (ranked 2nd, 2.1% of 1,814 corresponding-author articles). University of North Carolina published 10 single author articles (ranked 2nd, 4.8% of 207 single author articles).

3.5 *Authors*

There were 132 highly cited articles (6.9% of the 1,927 highly cited articles) with missing corresponding-author information in Web of Science database. Among the 5,660 authors contributing to 1,927 highly cited articles in the Web of Science category of health policy and services, 4,471 (79% of 5,660 authors) published only one highly cited article, 697 authors (12%) published two, 267 (4.7%) published three, and 93 (1.6%) published four. Following Ho (2014b) we applied four publication indicators – the total number of highly cited articles, first-author articles, corresponding-author articles, and single-author articles, to evaluate these highly cited authors. Table 4 lists the top 20 authors who published 10 or more highly cited articles with six publication indicators. The first-author in an article is normally considered the person who contributes most to the work, including conducting the research and writing the manuscript (Riesenberg and Lundberg, 1990; Ho and Hartley, 2016). The corresponding-author is responsible for responding to requests for information and copies of relevant papers (Burman, 1982). After data treatment, the names of the corresponding authors for 1,795 of 1,927 highly cited articles in the Web of Science category of health policy and services were found. Considering the overall contribution to the highly cited articles, J.E. Ware from Quality Metric Inc. in USA was the most prolific as he published 34 highly cited articles including 10 first-author articles, 11 corresponding-author articles, and two single author articles (Table 4). Ware used six affiliations as in Web of Science, including Rand Corp (3 articles in 1976, 1978, 1988), Tufts Univ New England Med Ctr (3 articles in 1994-1996), New England Med Ctr (2 articles in 1999), New England Med Ctr Hosp (one article in 1992), QualityMetric Inc (one article in 2000), and Qual Metr Inc (one article in 2001) for his 11 corresponding-author articles. Meanwhile, J.H. Hibbard from University of Oregon in the USA published 12 first-author and corresponding articles respectively. In addition, C.J. Ruhm from University of North Carolina in the USA published six highly cited articles including five single-author highly cited articles.

In total of 1,795 (93% of 1,927 articles) highly cited articles with both first and corresponding authors in SSCI were extensively analyzed by using the *Y*-index. It has been widely accepted that first and corresponding-authors has the most contribution to the overall paper (Gaeta, 1999; Mattsson et al., 2011). The *Y*-index was proposed in recent years (Ho, 2012; 2014a; 2014b) to evaluate publication potential and characterize the scientific contributions by authors, institutions, and countries in relations to the numbers of first-author publications (*FP*) and corresponding-author publications (*RP*). The *Y*-index has been widely implemented in highly cited articles in research fields (Fu and Ho, 2014; Fu and Hartley, 2016). The *Y*-index with two parameters (*j*, *h*) can aid in visualization and comparison among different authors' contributions and is expressed as:

$$j = FP + RP$$

$$h = \tan^{-1}\left(\frac{RP}{FP}\right)$$

where j represents publication potential with first-author and corresponding-author highly cited articles while h is a publication characteristics constant, that differentiates the leadership role.

When an author had a larger j value, the author would be positioned farther away from origin of the polar coordinates (0, 0) in the Y-index diagram (Fig. 3). When an author had the same number of first-author articles and corresponding-author articles, the author would be positioned in the diagonal line with an h value of 45° or 0.7854 (in radian).

The 1,795 highly cited articles with first and corresponding-author in Web of Science category of health policy and services were contributed by 5,348 authors. Only 1,293 highly cited authors (24% of the 5,348 authors) had both first and corresponding-author articles while 3,873 (72%) authors had no any first or corresponding-author articles, including 3,950 (74%) authors had no first-author article and 3,978 (74%) authors had no corresponding-author article. In particular, 77 authors (1.4% of the 5,348 authors) had only corresponding-author articles with h of $\pi/2$ and j is number of corresponding-author articles; 107 (2.0%) authors had more corresponding-author articles than first-author articles ($\pi/2 > h > 0.7854$); 1,222 (23%) authors had the equivalent numbers of first-author and corresponding-author articles ($h = 0.7854$); 11 (0.21%) authors had more first-author articles than corresponding-author articles ($0.7854 > h > 0$); and 105 (2.0%) authors had only first-author articles with h of 0 and j is number of first-author articles. Among 72 highly cited authors in Fig. 3, S.C. Kalichman (9, 0.6747) and J.A. Johnson (7, 0.6435) were the only two authors who had more first-author articles than corresponding-author articles. Figure 3 illustrates the distribution of the Y-index (j, h) of the top 72 authors with $j \geq 6$. Each point has a coordinate (j, h) that could symbolize a single author or multiple authors. Highly cited author J.H. Hibbard (24, 0.7854) from University of Oregon in USA published 13 highly cited articles including 12 articles each in the first-author category and the corresponding-author category. Hibbard had the highest j value of 24 indicated high publication potential for highly cited articles in Web of Science category of health policy and services, followed by J.E. Ware (20, 0.8851), A. Wagstaff (20, 0.7854), and S.M. Shortell (20, 0.7854). Y-index (j, h) is helpful in discerning the performances of the authors especially when j (first-author articles + corresponding-author articles) value is the same (Ho, 2014a). The j value of Ware, Wagstaff, and Shortell were identical ($j = 20$). However, h value of Ware was 0.8851 and h value of Wagstaff and Shortell was 0.7854. That could indicate Ware had a greater proportion of corresponding-author articles to first-author articles than others. Ware's data may also imply that they were part of the senior staff of the research team in overseeing the publication process of their article. Results also suggest that highly cited authors who published articles in health policy and services prefer to publish articles as first-author and also corresponding-author in the same articles. The same results were also reported

in Web of Science category of health care sciences and services (Hsu and Ho, 2014), horticulture (Kolle et al., 2017), and information science and library science (Ivanović and Ho, 2016). However, it is important to mention that with these data has a potential for bias in the analysis of authorship; it might attributes to different authors having the same name, or the same author using different names over time (Ho and Hartley, 2016).

3.6 *Classic sleeping beauties in Web of Science category of health policy and services*

A typical sleeping beauty in the scientific literature is "Versuche über Plflanzenhybriden" (Mendel, 1866). This paper was described as a sleeping beauty because its significance was not appreciated, and therefore citations did not accumulate, for over 30 years (Garfield, 1980). van Raan (2004) defined the three characteristics of such publications to be depth of sleep, length of sleep, and awakening intensity. Furthermore, long sleep and high impact sleeping beauties were also discussed (Ho and Hartley, 2017). Three sleeping beauties such as Williams (1990), Morisky et al. (1986), and Penchansky and Thomas (1981), among the 1,927 highly cited articles identified in the health policy and services were found. Table 5 provides more details for the sleeping beauties. Their citation histories were also presented in Fig. 4. Classic article with $TC_{2017} > 1{,}000$ (Long et al., 2014), entitled "EuroQol: A new facility for the measurement of health related quality of life" (Williams, 1990) published by Williams in *Health Policy* was identified as a classic sleeping beauty. This classic article had 14 years as less deep sleep. After such sleep (14 years) however, the annual citations increased slightly for another seven years and then increased sharply in last seven years (Fig. 4). Sleeping beauty entitled "Concurrent and predictive-validity of a self-reported measure of medication adherence" (Morisky et al., 1986) had an average citation per year of 2.0 in the first 6 years as less deep sleep. "The concept of access: Definition and relationship to consumer satisfaction" (Penchansky and Thomas, 1981) had an average citation per year of 2.0 in the first 13 years as less deep sleep.

3.7 *The classic articles in health policy and services*

There has been a long historical significance in the investigations of citation trends of scientific publication (Avramescu, 1979). In recent years, there have been numerous studies reporting the citation life cycles of highly cited articles ($TC_{year} \geq 100$) (Ho, 2012; Ivanović and Ho, 2018). It was shown that the number of citations were not always in high positions. (Ho and Kahn, 2014; Ho and Hartley, 2017). There were 28 classic articles with $TC_{2017} \geq 1{,}000$ in health care sciences and services and their citation lives are shown in Figs. 5-8. Table 6 records the TC_{2017} and C_{2017} of the 28 classic articles. Altogether 15 classic articles (54% of 28 classic articles) were published in *Medical Care* with $IF_{2017} = 3.338$, ranked 7th of 79 journals in the Web of Science category of health policy and services in 2017. The classic author John E. Ware, who published the most classic articles (n = 4) in the Web of Science category of health policy and services. Ware's group published four articles related to 36-Item Short-Form Health Survey (SF-36) and 12-Item Short-Form Health Survey (SF-12) (Ware and Sherbourne, 1992; Ware et al., 1996; McHorney et al., 1993; McHorney et

al., 1994). C.A. McHorney published two classic articles related to the MOS 36-Item Short-Form Health Survey (SF-36) as first author and also corresponding author (McHorney et al., 1993; McHorney et al., 1994). James W. Varni from Children's Hospital and Health Center at San Diego in California published two classic articles related to PedsQL as first author and also corresponding author (Varni et al., 2001; Varni et al., 1999).

The 13 high impact classic articles in 2017 with $C_{2017} \geq 200$ were highlighted as follows:

1) The MOS 36-Item Short-Form Health Survey (SF-36). I. Conceptual-framework and item selection (Ware and Sherbourne, 1992)

   This classic article was published in *Medical Care* by John E. Ware, Jr. from the Health Institute and International Resource Center for Health Care Assessment, New England Medical Center Hospitals in Massachusetts and Cathy Donald Sherbourne from the Social Policy Department, RAND Corporation in California. The article was not only the most impact in the most recent year with C_{2017} of 1,223 (ranked 1st) but also the most impact the most frequently cited with TC_{2017} of 18,879 (ranked 1st) in the Web of Science category of health policy and services. In this classic article, Ware and Sherbourne proposed a 36-Item Short-Form (SF-36) to survey health status in the Medical Outcomes Study. The SF-36 includes one multi-item scale that assesses eight health concepts: 1) limitations in physical activities because of health problems; 2) limitations in social activities because of physical or emotional problems; 3) limitations in usual role activities because of physical health problems; 4) bodily pain; 5) general mental health (psychological distress and well-being); 6) limitations in usual role activities because of emotional problems; 7) vitality (energy and fatigue); and 8) general health perceptions (Ware and Sherbourne, 1992). Ware and Sherbourne also summarized the history of the development of the SF-36, the origin of specific items, and the logic underlying their selection and compared with the 20-item Medical Outcomes Study short-form. The SF-36 was applied in clinical practice and research, health policy evaluations, and general population surveys after it was published and has been the most impact article in last two decades in the Web of Science category of health policy and services (Fig. 5). In addition, the International Quality of Life Assessment (IQOLA) Project was launched in 1991 to translate, adapt, and test the cross-cultural applicability of the SF-36 Health Survey (SF-36). Its sponsored investigators come from 14 different countries and the 15 additional countries in which preliminary work has begun is available elsewhere (Ware et al., 1995).

2) A 12-Item Short-Form Health Survey: Construction of scales and preliminary tests of reliability and validity (Ware et al., 1996)

   This classic article was also published in *Medical Care* by John E. Ware, Jr., Mark Kosinski, and Susan D. Keller from Health Institute, New England Medical Center in Massachusetts. The article was ranked 2nd in both C_{2017} and TC_{2017} of 748 and 7,366

respectively. In this classic article, Ware, Kosinski, and Keller presented a comparison of using regression methods to select and score 12 items from the Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36) to reproduce the Physical Component Summary and Mental Component Summary scales in the general US population (Ware et al., 1996). It was concluded that the choice of the SF-12 over the SF-36 is most justified in studies with large sample sizes having severe constraints on questionnaire length and in studies focusing on patient-based assessments of physical and mental health (Ware et al., 1996). Citation trend in Fig. 5 shows that the 12-Item Short-Form Health Survey will be the mainly applied in health policy and services.

3) Consolidated criteria for reporting qualitative research (COREQ): A 32-item checklist for interviews and focus groups (Tong et al., 2007)

   This classic article was published in *International Journal for Quality in Health Care* by Allison Tong, Peter Sainsbury, and Jonathan Craig from University of Sydney in Australia. The article had C_{2017} of 599 (ranked 3rd) and TC_{2017} of 1,893 (ranked 12th). Due to qualitative research explores complex phenomena encountered by clinicians, health care providers, policy makers and consumers. Authors developed a checklist for explicit and comprehensive reporting of qualitative studies. Seventy-six items from 22 checklists found in Cochrane and Campbell Protocols, Medline, and CINAHL were compiled into a comprehensive list. All items were grouped into three domains: (i) research team and reflexivity, (ii) study design and (iii) data analysis and reporting. It was concluded that the criteria included in COREQ, a 32-item checklist, can help researchers to report important aspects of the research team, study methods, context of the study, findings, analysis and interpretations. Figure 6 shows that the 32-item checklist has been popularly applied in related fields since 2010.

4) Comorbidity measures for use with administrative data (Elixhauser et al., 1998)

   This classic article was also published in *Medical Care* by Anne Elixhauser from MEDTAP International Inc. in Maryland, Claudia Steiner from the Agency for Health Care Policy and Research Center for Organization & Delivery Systems in Maryland, D. Robert Harris from WESTAT Inc. in Maryland, and Rosanna M. Coffey from MEDSTAT Group Inc. in Washington D.C. The article was ranked 4th in both C_{2017} and TC_{2017} of 501 and 3,301 respectively. The comorbidities had independent effects on outcomes and probably should not be simplified as an index because they affect outcomes differently among different patient groups (Elixhauser et al., 1998). Elixhauser, Steiner, Harris, and Coffey developed a comprehensive set of comorbidity measures for use with large administrative inpatient datasets. The method addresses some of the limitations of previous measures. Citation trend in Fig. 5 shows that the classic article had a sharply increasing citation trend especially after 2010.

5) Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data (Quan et al., 2005)

This classic article was also published in *Medical Care* by Hude Quan and other nine authors from University of Calgary in Canada, University of Lausanne in Switzerland, and University of Alberta in Canada. The article had C_{2017} of 459 (ranked 5th) and TC_{2017} of 2,448 (ranked 8th). Authors conducted a multistep process to develop ICD-10 coding algorithms to define Charlson and Elixhauser comorbidities in administrative data and assess the performance of the resulting algorithms. It was concluded that the developed ICD-10 and ICD-9-CM comorbidity coding algorithms produce similar estimates of comorbidity prevalence in administrative data, and may outperform existing ICD-9-CM coding algorithms. The classic article had a sharply increasing on citations after its publication (Fig. 6).

6) EuroQol: A new facility for the measurement of health related quality of life (Williams, 1990)

This classic article was also published in *Health Policy* by Alan Williams and the EuroQol Group from Centre for Health Economics at University of York in the United Kingdom. The article had C_{2017} of 447 (ranked 6th) and TC_{2017} of 1,324 (ranked 20th). The term 'EuroQol' is the copyright of the EuroQol Group (Williams, 1990). In 1987, the EuroQol Group first met to test the feasibility of jointly developing a standardised non-disease-specific instrument for describing and valuing health-related quality of life (Brooks, 1996). The EuroQol instrument is intended to complement other forms of quality of life measures, and it was purposefully developed to generate a cardinal index of health, thus giving it considerable potential for use in economic evaluation. In this article, the EuroQol Group conducted postal surveys in England, the Netherlands, and Sweden which indicate a striking similarity in the relative valuations attached to 14 different health states. The data were collected using a visual analogue scale similar to a thermometer. The EuroQol instrument is intended to complement other quality-of-life measures and to facilitate the collection of a common data set for reference purposes.

7) Fostering implementation of health services research findings into practice: A consolidated framework for advancing implementation science (Damschroder et al., 2009)

This classic article was also published in *Implementation Science* by Laura J Damschroder and other five authors from VA Ann Arbor Healthcare System (11H) in USA, Louis Stokes Cleveland DVAMC in USA, and University of Michigan in USA. The article had C_{2017} of 402 (ranked 7th) and TC_{2017} of 1,348 (ranked 19th). The classic article was published in latest year. However, there is a sharply increasing on citations after its publication (Fig. 7). It was widely used to guide formative evaluations and build the implementation knowledge base across multiple studies and settings (Damschroder et al., 2009). In this article, authors reported that the Consolidated Framework for Implementation Research (CFIR) provides a pragmatic structure for

approaching complex, interacting, multi-level, and transient states of constructs in the real world by embracing, consolidating, and unifying key constructs from published implementation theories (Damschroder et al., 2009).

8) The Triple Aim: Care, health, and cost (Berwick et al., 2008)

   This classic article was also published in *Health Affairs* by Donald M. Berwick, Thomas W. Nolan, and John Whittington from the Institute for Healthcare Improvement (IHI) in Cambridge of Massachusetts. The article had C_{2017} of 339 (ranked 8th) and TC_{2017} of 1,351 (ranked 18th). Authors proposed the "Triple Aim": improving the individual experience of care; improving the health of populations; and reducing the per capita costs of care for populations; for work to improve site-specific care for individuals should expand and thrive. From experiments in the United States and from examples of other countries, it is now possible to describe feasible, evidence-based care system designs that achieve gains on all three aims at once: care, health, and cost. The classic article published in latest year had a sharply increasing on citations after its publication (Fig. 7).

9) EuroQol: The current state of play (Brooks, 1996)

   This classic article was published in *Health Policy* by Richard Brooks from Department of Economics at University of Strathclyde in the United Kingdom and the 23 members of the EuroQol Group. The article had 279 (ranked 10th) and TC_{2017} of 2,696 (ranked 7th). Brooks presented a history of the EuroQol Group in the classic article, including EuroQol: the current state of play, the EuroQol instrument, concepts, valuation, evidence on methodological requirements, special issues, applications, and future developments. The classic article had a smoothly increasing on citations after its publication (Fig. 5).

10) Concurrent and predictive-validity of a self-reported measure of medication adherence (Morisky et al., 1986)

    This classic article was published in *Medical Care* by Donald E. Moriskys from University of California at Los Angeles in USA, Lawrence W. Green from University of Texas at Houston in USA, and David M. Levin from Johns Hopkins Medical Institutions in USA. The article had 229 (ranked 13th) and TC_{2017} of 2,056 (ranked 10th). Authors review the psychometric properties and tests the concurrent and predictive validity of a structured four-item self-reported adherence measure, which can be easily integrated into the medical visit. Items in the scale address barriers to medication-taking and permit the health care provider to reinforce positive adherence behaviors. This classic article is a sleeping beauty. Figure 6 shows the article had less citation for a decade, after that a smoothly increasing of citations was appeared. It was highly cited in recent year.

11) The Patient Health Questionnaire-2: Validity of a two-item depression screener (Kroenke et al., 2003)

This classic article was published in *Medical Care* by Kurt Kroenke from Indiana University in USA, and Robert L. Spitzer and Janet B. W. Williams from Columbia University in USA. The article had 223 (ranked 14th) and TC_{2017} of 1,356 (ranked 17th). Authors evaluated a 2-item version of the PHQ depression module, the Patient Health Questionnaire-2 (PHQ-2). It was concluded that the construct and criterion validity of the PHQ-2 make it an attractive measure for depression screening. Citations of the classic article keep increasing after its publication in 2003 (Fig. 7).

12) The MOS 36-Item Short-Form Health Survey (SF-36). II. Psychometric and clinical-tests of validity in measuring physical and mental-health constructs (McHorney et al., 1993)

This classic article was published in *Medical Care* by Colleen A. McHorney, John E. Ware, Jr., and Anastasia E. Raczek from Health Institute, New England Medical Center in Massachusetts. The article had C_{2017} of 204 (ranked 15th) and TC_{2017} of 3,945 (ranked 3rd). McHorney, Ware, and Raczek reported analysis of cross-sectional data from the Medical Outcomes Study (MOS) to test the validity of the MOS 36-Item Short-Form Health Survey (SF-36) scales as measures of physical and mental health constructs. This study identified the valid approach to evaluate physical and mental health dimensions, including severity of medical and psychiatric conditions, social functioning, vitality, and general health perceptions scales, and established guidelines for the interpretation of the SF-36 Survey.

13) Modeling valuations for EuroQol health states (Dolan, 1997)

This classic article was published in *Medical Care* by Paul Dolan from University of Newcastle Upon Tyne in the United Kingdom. The article had C_{2017} of 202 (ranked 16th) and TC_{2017} of 2,255 (ranked 9th). EuroQol is designed to derive a single index value and this article reports on the methodology that was adopted to build up a "tariff" of EuroQol values. Authors concluded that the model predicts the values of the states for which there are direct observations and, thus, can be used to interpolate values for the states for which no direct observations exist. The model built by Dolan has validated to predict value and can be used to interpolate values, when the preference-based measures of health-related quality of life to be used in the evaluation of different health-care interventions.

Conclusions

A total of 1,927 highly cited articles were found in Web of Science category of health policy and services from 1967 to 2016. The most highly cited were published in the 2000s while the highest citations per publication was in 1992. *Medical Care* published the most articles. *BMJ Quality & Safety* with the highest journal impact factor published less highly cited articles. The US dominated the production by 80% of total highly cited articles. Harvard University was the world leader and dominated most of the highly cited. Result from *Y*-index shows that J.H. Hibbard had highest potential to publish highly cited articles

followed by J.E. Ware, S.M. Shortell, and A. Wagstaff. All top three most frequently cited classic articles related to 36-Item Short-Form Health Survey (SF-36) were published by Ware's group from Health Institute, New England Medical Center in Massachusetts. The MOS 36-Item Short-Form Health Survey (SF-36) and EuroQol were the most popular research focuses in health policy and services.

Based on the analysis of this study, we could find the most cited articles in this field are index developmental articles, and the SF-36 series articles are the most. When research involves individual health issues, consider using the SF-36 developed by Medical Outcomes Study developed in the early 1980s, and there are already different language versions that have been cited and developed by various countries. This topic occupies three highly cited articles in health policy and service field. We can learn that health measurement index with broader significance than clinical indicators besides its extensive scale development scope and dimensions. The development of health measurement indicators not only considers the impact of physical, psychological and social functions on the quality of life, but also conforms to international trends and the needs of the times. It also be used as the long-term accumulation and medical quality measurement indicators with continuous improvement.

Table 1

The top 10 most productive journals

Journal	*TP* (%)	IF_{2017} (rank)	*APP*	CPP_{2017}
Medical Care	474 (25)	3.338 (7)	4.7	310
Health Affairs	238 (12)	4.843 (4)	3.9	191
Psychiatric Services	141 (7.3)	2.205 (24)	4.8	167
Quality of Life Research	135 (7.0)	2.392 (18)	5.0	220
Journal of Health Economics	118 (6.1)	3.250 (8)	2.9	220
Health Services Research	105 (5.4)	2.667 (11)	4.4	199
Health Economics	70 (3.6)	2.319 (20)	3.1	200
Milbank Quarterly	63 (3.3)	6.000 (2)	3.2	193
Value in Health	48 (2.5)	5.494 (3)	6.5	220
Future of Children	41 (2.1)	1.588 (46)	2.2	203

TP: total number of highly cited articles; IF_{2017}: impact factor in 2017; *APP*: number of authors per publication; CPP_{2017}: citations per publication (TC_{2017}/TP).

Table 2

Top 12 productive countries with six publication indicators.

Country	*TP*	*TP R* (%)	*IP R* (%)	*CP R* (%)	*FP R* (%)	*RP R* (%)	*SP R* (%)
USA	1,517	1 (80)	1 (83)	1 (65)	1 (77)	1 (76)	1 (75)
UK	230	2 (12)	2 (5.6)	2 (50)	2 (7.7)	2 (7.8)	2 (12)
Canada	160	3 (8.4)	3 (4.4)	3 (32)	3 (5.2)	3 (5.1)	6 (1.0)
Netherlands	86	4 (4.5)	4 (1.9)	4 (20)	4 (2.6)	4 (2.6)	4 (1.9)
Australia	58	5 (3.1)	5 (1.7)	5 (11)	5 (1.8)	5 (1.9)	3 (2.9)
Sweden	46	6 (2.4)	6 (1.0)	5 (11)	6 (1.1)	6 (1.0)	4 (1.9)
Switzerland	35	7 (1.8)	7 (0.31)	5 (11)	8 (0.53)	8 (0.50)	9 (0.48)
Germany	32	8 (1.7)	9 (0.25)	8 (10)	7 (0.68)	7 (0.72)	9 (0.48)
Denmark	22	9 (1.2)	7 (0.31)	11 (6.1)	12 (0.32)	13 (0.33)	6 (1.0)
Italy	22	9 (1.2)	9 (0.25)	9 (6.5)	14 (0.26)	14 (0.28)	N/A
France	21	11 (1.1)	9 (0.25)	11 (6.1)	11 (0.37)	11 (0.39)	9 (0.48)
Spain	20	12 (1.1)	16 (0.12)	9 (6.5)	10 (0.42)	10 (0.44)	N/A

TP: number of total articles; *IP*: independent articles; *CP*: internationally collaborative articles; *FP*: first-author articles; *RP*: corresponding-author articles: *SP*: single-author articles; *R*: rank; N/A: not available.

Table 4

Top 10 productive institutions with six publication indicators.

Institution	*TP*	*TP R* (%)	*IP R* (%)	*CP R* (%)	*FP R* (%)	*RP R* (%)	*SP R* (%)
Harvard University, USA	200	1 (11)	1 (3.4)	1 (14)	1 (4.4)	1 (4.2)	1 (5.3)
University of California Los Angeles, USA	100	2 (5.3)	7 (2.2)	2 (6.6)	4 (2.0)	3 (1.9)	9 (1.4)
University of Washington, USA	85	3 (4.5)	13 (1.4)	3 (5.9)	8 (1.8)	9 (1.5)	17 (1.0)
RAND Corporation, USA	76	4 (4.0)	8 (1.9)	4 (5.0)	5 (1.9)	3 (1.9)	9 (1.4)
University of California San Francisco, USA	75	5 (4.0)	5 (2.7)	5 (4.5)	3 (2.2)	2 (2.1)	7 (2.4)
Johns Hopkins University, USA	74	6 (3.9)	3 (3.2)	6 (4.2)	2 (2.3)	3 (1.9)	4 (2.9)
University of Michigan, USA	70	7 (3.7)	1 (3.4)	7 (3.8)	8 (1.8)	7 (1.9)	3 (3.9)
University of Pennsylvania, USA	66	8 (3.5)	4 (3.0)	9 (3.7)	5 (1.9)	3 (1.9)	4 (2.9)
Yale University, USA	56	9 (3.0)	15 (1.0)	7 (3.8)	11 (0.95)	15 (0.77)	17 (1.0)
University of North Carolina, USA	55	10 (2.9)	5 (2.7)	11 (3)	7 (1.8)	8 (1.8)	2 (4.8)

TP: total number of highly cited articles; *TPR* (%), *IPR* (%), *CPR* (%), *FPR* (%), *RPR* (%), and *SPR* (%): the rank and percentage of total articles, single institution articles, inter-institutionally collaborative articles, first-author articles, corresponding-author articles, single-author articles in their total articles.

Table 4

The top 20 productive authors with *TP* ≥ 10

Author	Affiliation	Rank (*TP*)	Rank (*FP*)	Rank (*RP*)	Rank (*SP*)
J.E. Ware	Quality Metric Inc., USA	1 (34)	2 (10)	2 (11)	6 (2)
R.D. Hays	University of California, Los Angeles, USA	2 (21)	9 (6)	8 (6)	N/A
L.H. Aiken	University of Pennsylvania, USA	3 (15)	6 (8)	6 (8)	N/A
R.E. Drake	New Hampshire Dartmouth Psychiatric Research Center, USA	3 (15)	44 (3)	39 (3)	N/A
S.M. Shortell	University of California, Berkeley, USA	5 (14)	2 (10)	3 (10)	N/A
P.D. Cleary	Harvard University, USA	6 (13)	24 (4)	15 (5)	N/A
J.H. Hibbard	University of Oregon, USA	6 (13)	1 (12)	1 (12)	N/A
D.A. Revicki	MEDTAP International Inc., USA	6 (13)	7 (7)	7 (7)	N/A
C. Schoen	Commonwealth Fund, USA	6 (13)	5 (9)	5 (9)	N/A
A. Wagstaff	World Bank, USA	6 (13)	2 (10)	3 (10)	2 (4)
D.W. Bates	Brigham and Women's Hospital, USA	11 (11)	44 (3)	39 (3)	19 (1)
R.H. Brook	RAND Corporation, USA	11 (11)	44 (3)	39 (3)	N/A
D. Cella	Evanston Northwestern Health, USA	11 (11)	24 (4)	24 (4)	N/A
V. Mor	Brown University, USA	11 (11)	24 (4)	15 (5)	19 (1)
B. Starfield	Johns Hopkins University, USA	11 (11)	44 (3)	82 (2)	N/A
E. Van Doorslaer	Erasmus University, Netherlands	11 (11)	15 (5)	15 (5)	N/A
M. Johannesson	Stockholm School of Economics, Sweden	17 (10)	24 (4)	24 (4)	N/A
M. Kosinski	Quality Metric Inc., USA	17 (10)	44 (3)	245 (1)	N/A
D.L. Patrick	University of Washington, USA	17 (10)	15 (5)	15 (5)	N/A
M.C. Weinstein	Harvard University, USA	17 (10)	44 (3)	39 (3)	N/A

TP: total number of highly cited articles; *FP*: first-author articles; *RP*: corresponding-author articles; *SP*: single-author articles

Table 5

Comparison data for three classic sleeping beauties in health policy and services

Sleeping beauties	TC_{2017}	C_{2017}	No. of years sleeping
Williams (1990)	1,324	447	14
Morisky et al. (1986)	2,056	229	6
Penchansky and Thomas (1981)	756	105	13

TC_{2017}: total number of citations from Web of Science Core Collection; C_{2017}: total number of citations in 2017

Table 6

The 28 classic articles in Web of Science category of health policy and services

Rank (TC_{2017})	Rank (C_{2017})	Article title	Reference
1 (18,879)	1 (1,223)	The MOS 36-Item Short-Form Health Survey (SF-36). I. Conceptual-framework and item selection	Ware and Sherbourne (1992)
2 (7,366)	2 (748)	A 12-Item Short-Form Health Survey: Construction of scales and preliminary tests of reliability and validity	Ware et al. (1996)
3 (3,945)	15 (204)	The MOS 36-Item Short-Form Health Survey (SF-36). II. Psychometric and clinical-tests of validity in measuring physical and mental-health constructs	McHorney et al. (1993)
4 (3,301)	4 (501)	Comorbidity measures for use with administrative data	Elixhauser et al. (1998)
5 (3,163)	80 (61)	The sickness impact profile: Development and final revision of a health status measure	Bergner et al. (1981)
6 (2,797)	29 (127)	The MOS 36-Item Short-Form Health Survey (SF-36). III. Tests of data quality, scaling assumptions, and reliability across diverse patient groups	McHorney et al. (1994)
7 (2,696)	10 (279)	EuroQol: The current state of play	Brooks (1996)
8 (2,448)	5 (459)	Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data	Quan et al. (2005)
9 (2,255)	16 (202)	Modeling valuations for EuroQol health states	Dolan (1997)
10 (2,056)	13 (229)	Concurrent and predictive validity of a self-reported measure of medication adherence	Morisky et al. (1986)
11 (1,921)	50 (97)	The price of innovation: New estimates of drug development costs	Dimasi et al. (2003)
12 (1,893)	3 (599)	Consolidated criteria for reporting qualitative research (COREQ): A 32-item checklist for interviews and focus groups	Tong et al. (2007)
13 (1,771)	18 (191)	PedsQL^{TM} 4.0: Reliability and validity of the pediatric quality of life Inventory^{TM} Version 4.0 generic core scales in healthy and patient populations	Varni et al. (2001)
14 (1,677)	19 (176)	Interpretation of changes in health-related quality of life: The remarkable universality of half a standard deviation	Norman et al. (2003)

Contd...

15 (1,458)	36 (117)	The estimation of a preference-based measure of health from the SF-36	Brazier et al. (2002)
16 (1,406)	33 (122)	Improving chronic illness care: Translating evidence into action	Wagner et al. (2001)
17 (1,356)	14 (223)	The Patient Health Questionnaire-2: Validity of a two-item depression screener	Kroenke et al. (2003)
18 (1,351)	8 (339)	The triple aim: Care, health, and cost	Berwick et al. (2008)
19 (1,348)	7 (402)	Fostering implementation of health services research findings into practice: A consolidated framework for advancing implementation science	Damschroder et al. (2009)
20 (1,324)	6 (447)	EuroQol: A new facility for the measurement of health related quality of life	Williams (1990)
21 (1,223)	68 (71)	The epidemiologic transition: A theory of epidemiology of population change	Omran (1971)
22 (1,174)	35 (118)	The PedsQL™: Measurement model for the pediatric quality of life inventory	Varni et al. (1999)
23 (1,160)	20 (158)	The World Health Organization's WHOQOL-BREF quality of life assessment: Psychometric properties and results of the international field trial - A report from the WHOQOL group	Skevington et al. (2004)
24 (1,086)	73 (69)	Evidence suggesting that a chronic disease self-management program can improve health status while reducing hospitalization: A randomized trial	Lorig et al. (1999)
25 (1,081)	61 (75)	Assessing health status and quality of life instruments: Attributes and review criteria	Aaronson et al. (2002)
26 (1,066)	24 (137)	Annual medical spending attributable to obesity: Payer- and service-specific estimates	Finkelstein et al. (2009)
26 (1,066)	65 (73)	Effect sizes for interpreting changes in health status	Kazis et al. (1989)
28 (1,041)	39 (113)	Estimating log models: To transform or not to transform?	Manning and Mullahy (2001)

TC_{2017}: total number of citations from Web of Science Core Collection; C_{2017}: total number of citations in 2017

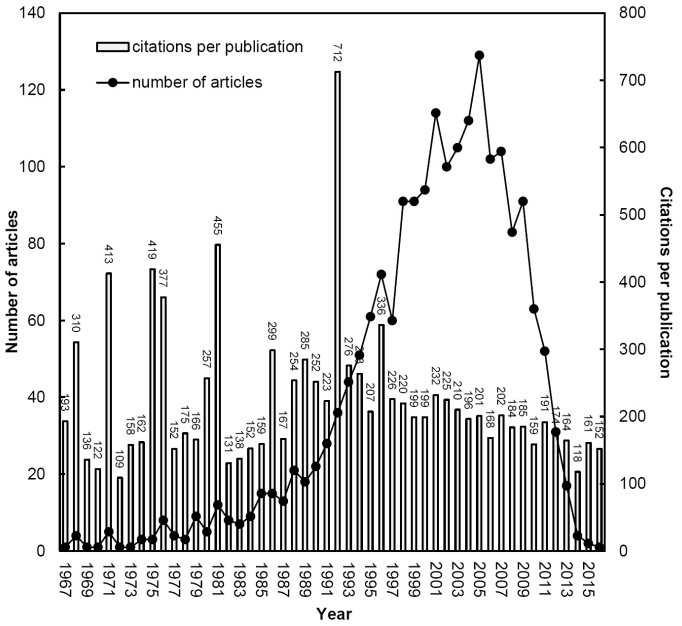

Figure 1

Annual number of articles and citations per publication by year.

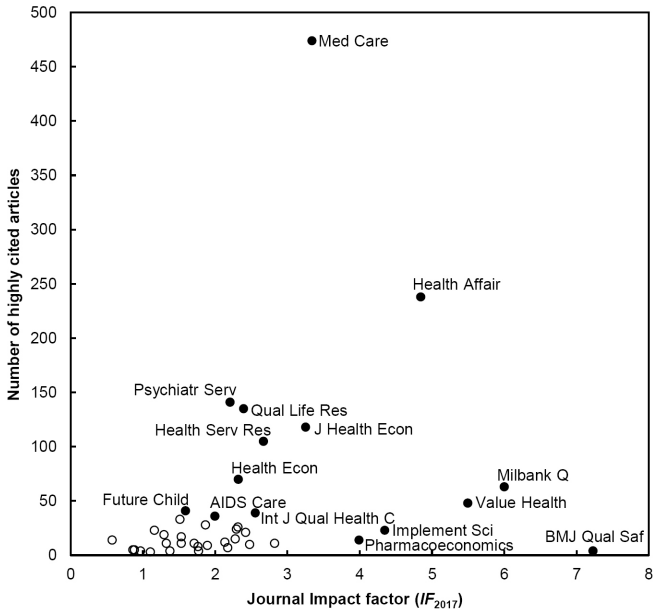

Figure 2

Impact factors' distribution of journals in Web of Science category of health policy and services

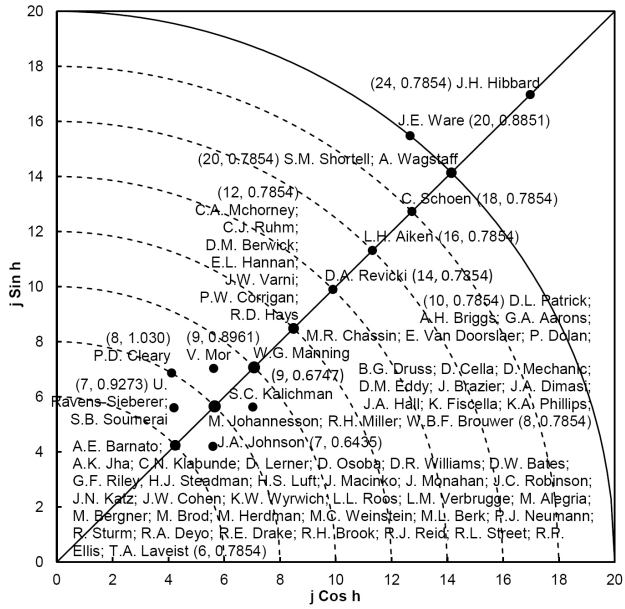

Figure 3

Top 72 authors with Y-index ($j \geq 6$)

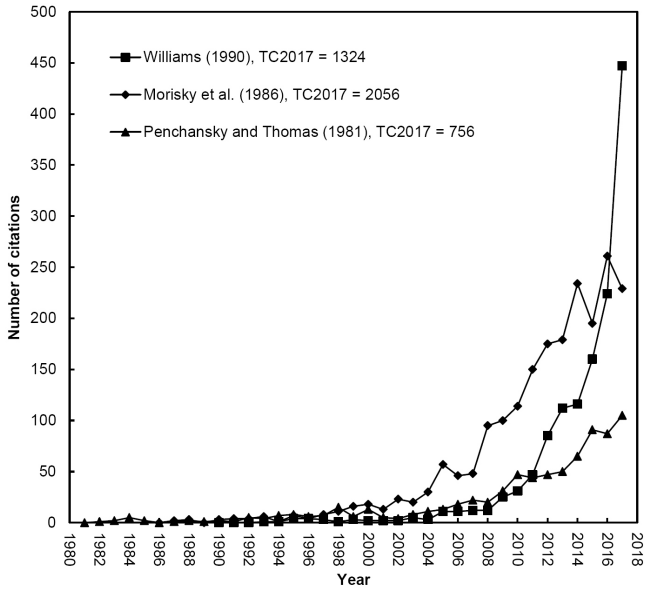

Figure 4

Three sleeping beauties in health policy and services

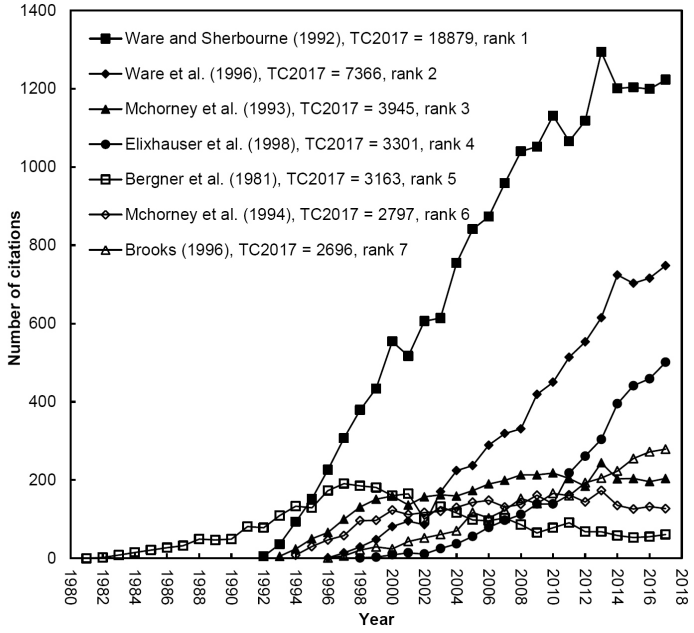

Figure 5

Citation histories of the top seven highly cited articles

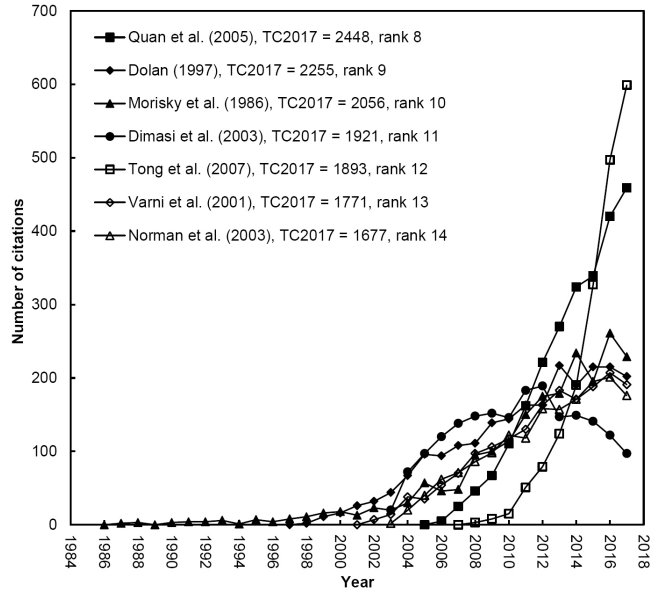

Figure 6

Citation histories of the 8-14 highly cited articles

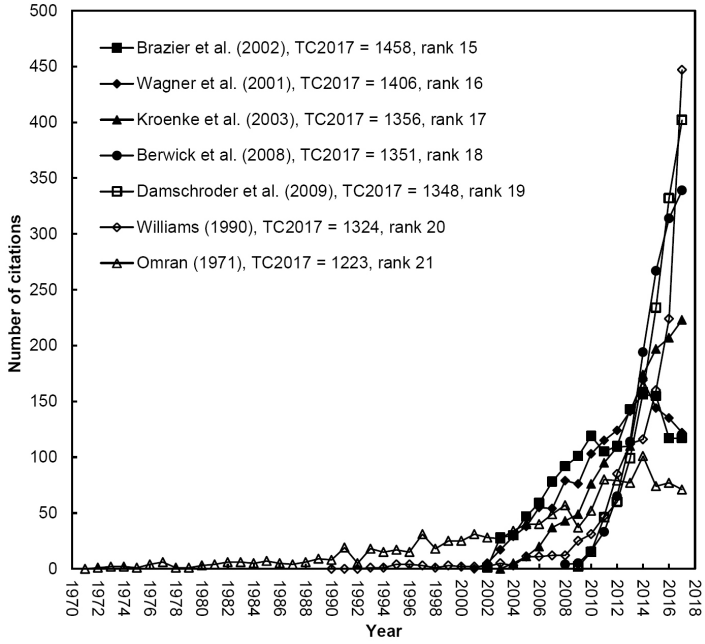

Figure 7

Citation histories of the 15-21 highly cited articles

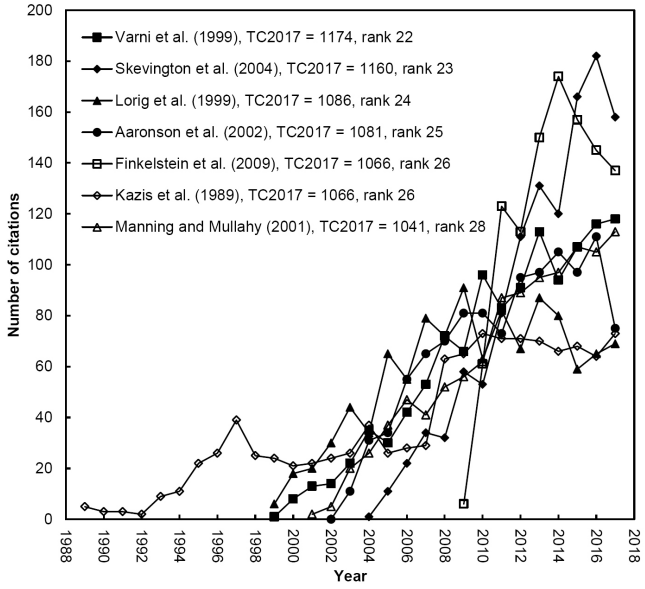

Figure 8

Citation histories of the 22-26 highly cited articles

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