Top-Cited Articles In Medical Professionalism:
A Bibliometric Analysis versus Altmetric Scores

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SHORT TITLE: Most cited in Medical Professionalism
Abstract

Background: Citation counts of articles have been used by universities and funding bodies to measure scientific outcomes and assess suitability for grant applications. However, citation counts are not without limitations. With the rise of social media, altmetric scores may provide an alternative assessment tool.

Objectives: The aims of this study are to assess the characteristics of highly cited articles in medical professionalism and altmetric scores.

Methods: The Web of Science was searched for top-cited articles in medical professionalism, and the characteristics of each article were identified. The altmetric database was searched to identify report for each article. A model to assess the relationship between the number of citations and each of key characteristics as well as altmetric scores were developed.

Results: No correlations were found between the number of citations and number of years since publication (p=0.192), number of institutes (p=0.081), number of authors (p=0.270), females in authorship (p=0.15), or number of grants (p=0.384). The altmetric scores varied from zero to 155, total= 806, median=5.0, (IQR=20). Twitter (54%) and Mendeley (62%) were the most popular altmetric resources. No correlation was found between the number of citations and the altmetric scores (p=0.661). The top topics covered were learning and teaching professionalism, curriculum issues, professional and unprofessional behavior, defining and measuring professionalism. Only the number of countries correlated with the number of citations (p= 0.001). The articles were mainly published in Academic Medicine, Journal of the American Medical Association, Journal of General Internal Medicine, and Annals of Internal Medicine.

Conclusions: Except for the number of countries involved, no correlation was found between citations and any of the article parameters. Altmetric scores of articles were not significantly correlated with citations. Highly cited articles were produced mainly by the United States, Canada, and the United Kingdom. The study reflects the emerging role of altmetric and social media in the dissemination of research. Future studies should investigate the specific features of highly cited articles and factors that reinforce distribution of research data among scholars and non-scholars.
**KEYWORDS:** Medical professionalism, Professional behavior, Top-cited articles, Citation analysis, Altmetric scores.

**Introduction**

Citation counts have been used by universities and funding bodies to measure scientific outcomes, make decisions about professional promotion, and assess suitability for grant applications [1,2]. It has been even claimed that the higher the number of citations received, indicates a higher quality of work and it has been seen as a valuable trigger attracting more scientists to cite the work. While these claims may not necessarily be true, there is a substantial body of evidence that the number of citations to scientist’s publications correlates with other research impacts made including achievements awards, honors, and Nobel laureateship [3,4], prestigious research positions [5], research grants received, academic ranking [6], and peer judgment [7]. However, there are a number of factors, other than scientific quality, that may play a role in the decision to cite and many researchers doubt that citation counts can reflect the impact of scientific activity [8]. There is evidence that early interest in a research publication reflected by online access within a week of publication predicts citations up to 15 years later [9]. Also scientific citations favor positive results and authors tend to cite primarily works by authors with whom they know and personally acquainted [10,11].

With these limitations in mind, there is a continuous search for alternatives or meters that can complement the citation counts. Currently, there is a rising interest in altmetric scores. Contrary to traditional citation-based analysis, the altmetrics reflect the widespread attention to published scientific articles and the rise of social media for dissemination and discussion of
scientific information. Therefore, it is possible to quantify discussion of an article on blogs, news media or other social media platforms [12].

Considering these two measures, it was decided to assess the highly cited articles on medical professionalism [13,14]. The top-cited articles were selected because an earlier study revealed a number of attributes of articles on medical professionalism [14]. The use of altmetric scores in this study in particular is thought to be useful since articles on professionalism are usually shared on social media.

Therefore, the aims of the present article are: First, identify the most cited articles in medical professionalism and evaluate their characteristics and any correlations between the number of citations and the number of years since publications, the number of institutes, the number of countries involved, the number of authors, the number of females in authorship, grants received and the journal impact factor (JIF) of the journals in which these articles were published. Second, assess the impact of such articles on social media by calculating altmetric scores and conducting an exploratory analysis examining the altmetric findings compared to citation analysis. The findings from this study could enable researchers to identify common features of articles behind the progress of medical professionalism and key topics raised in these articles over the last two decades. As well as explore the relationship between citation analysis and altmetric scores.

**Methods**

**Study Design**

To achieve the objectives of this study, it was decided to search the Web of Science database of the Thomson Reuters for highly cited articles and track the citation records of publications
identified. To achieve the first aim we planned to identify the highly cited articles in medical professionalism and their characteristics using a number of mechanisms, explained in detail below. For the second aim the altmetric bookmarklet application was used to obtain the altmetric scores and construct exploratory analysis examining the role of social media and the different resources contributing to altmetrics. At the end, we compared these findings with those obtained from the citation analysis. While the search of the altmetrics, described below, was carried out for the first time by our group, the search of the Web of Science database for top-cited article and the protocol for the method used has been described in detail in our earlier publications [15,16,17]. A summary of these steps is presented below.

**Searching the Web of Science Database**

Searching the Web of Science database was carried out in the 5th of April 2017 by two researchers (SAA is a professor of medical education with 20 years experience in research in the field of medical education and professionalism, and SA a medical registrar and researcher). The search words used were the following: “Medical professionalism”, “Patient safety”, “Professional behavior”, “Unprofessional behavior”, “Role modeling”, “Accountability”, “Faculty training in professionalism”, “Altruism”, “Physician code”, “Physician charter”, “Medical ethics”, “Integrity”, “Consent”, “Defining medical professionalism”, “Empathy”, “Compassionate doctor”, “Professional conduct”, “Collaborative doctor”, “Self-assessment”, “Professional development”, “Resilient doctor”, “Social justice”, “Patient autonomy”, “Patient Welfare”, “Professional responsibility”, “Managing conflict”, Patient confidentiality”, “Quality of care”, “Social contract”, “Team work and professionalism”, “Personal development”, “Public professionalism”, “Interpersonal professionalism”, and ‘Intrapersonal professionalism’. These search words were identified
from the terminology used in defining medical professionalism including [18-23]. For each search word, the results were arranged using a link on the Web of Science database system “sort-by” – “Time Cited- highest to lowest”. The results showed the articles organized in a descending order with the articles most frequently cited on the top. The findings from each search word were then arranged on one Excel sheet in a descending order based on the number of citations. Duplicate articles and articles not in the English language were excluded. Articles with identical absolute number of citations were ranked on the basis of the average citation per year (the number of citations obtained divided by the number of years since published) [24]. A copy of all papers included in the list was obtained and read by the evaluators.

To maximise the yield of the search and detect any article that was not identified in the first search, another search was conducted, on the same day, using the above mentioned search words targeting the websites of journals in medical education, general medicine and surgery, and biomedical ethics. The journals were selected on the basis of the outcomes of the Web of Science search and the references cited by the articles identified. This search was particularly important as for example, Teaching and Learning in Medicine first appeared in Web of Science in 1996 but the journal was published since 1989. Therefore, any relevant articles from this journal or others prior to 1996 would be included. The journals in medical education that were searched included Academic Medicine, Medical Education, Medical Teacher, BMC Medical Education, Advances in Health Sciences Education Theory, and Practices, Teaching and Learning in Medicine, and the Journal of Continuing Education in the Health Professions. The journals searched in general medicine and surgery were the New England Journal of Medicine, the Lancet, the British Medical Journal, the Journal of the American
Medical Association, Journal of General Internal Medicine, Annals of Internal Medicine, Archives of Internal Medicine, Canadian Medical Association Journal, PLOS Medicine, Annals of Surgery, Archives of Surgery, British Journal of Surgery, Perspectives in Biology and Medicine, Mayo Clinic Proceedings, and the Australian Medical Journal. The journals in bioethics that were searched included the American Journal of Bioethics, Journal of Medical Ethics, and BMC Medical Ethics.

**Inclusion And Exclusion Criteria**

The inclusion criteria were: (i) papers focusing on medical professionalism in the English language, and (ii) articles, reviews, research papers, reports, editorials on any aspect related to medical professionalism in the English language. The exclusion criteria were: (i) articles on medical professionalism in languages other than English, and (ii) articles that focused on education/curriculum or clinical practices and medical professionalism was not the main focus.

**Assessing the Articles**

For each of the identified articles (Appendix 1), a full text was obtained and a copy was given to each researcher. The following information was collected: (i) the authors’ names and their affiliations, and the number of females contributing to authorship (ii) the number of institutes involved and the city and country of the origin of the publication, (iii) the total number of citations obtained up to the day of searching the database, and the number of yearly citations since publication, (iv) the year of publication and the calculated number of years since publication, and (v) grants/funding bodies stated in the publication and (vi) the 2016-JIF of the journal that published the work.
We also aimed at grouping the identified top-cited articles into categories. We have not used the categories provided by the Web of Science “study type” because we noted that the Web of Science system does not differentiate between “original research” or “articles” and classified both as “articles”. For consistency and the purpose of this study, we grouped the articles into four categories - article, review, editorial material, and research. A definition of each category is given in the glossary. Using these definitions, two researchers independently allocated each article under a category. For articles that were difficult to classify or not fitting into the same category, a meeting was held to discuss these articles and a final decision was made.

The topics covered in most cited articles were identified by each researcher independently by creating key words reflecting the main idea covered in an article and using these words to phrase a short statement that could help in grouping more than one article under one topic. The topics were then discussed in a meeting to harmonize the grouping into a logical, simple and practical way. Articles covering more than one topic were classified on the basis of the aim of the study, the title and the main outcomes. Regarding the data collected for each article, it is important to mention here that the identification of females in the list of authorship was a challenging task particularly when a journal uses abbreviations of the first and second name rather than the full name. In order to identify the females in these articles we searched the Google database to find the university, personal website of the author, their Linkedin, or ResearchGate accounts. In some cases we tried to identify them by searching the Google Scholar database and identify their accounts, where we can find other publications under their names and the full first name or a photo showing them.

**Altmetric system**
The altmetric system comprises, but not limited to, policy documents, news, blogs, tweeters, online reference managers (e.g., Mendeley, CitULike), post-publication peer reviews (e.g., PubPeer, Publons), Social media platforms (e.g., Facebook, Google+, Pinterest), citations on Wikipedia, sites running Stack Exchanges (Q&A), and reviews on Faculty 1000 (F1000) and YouTube. Therefore, altmetric scores may reflect interest of the public as well as clinicians and researchers in a publication and the scores may provide information about the geographical and demographic details of those involved in such online/social media discussions [25].

The altmetric program process raw data collected from the above mentioned resources and the data is weighted according to a system created by altmetrics to reflect the relative contribution of each source to the total altmetric score. News, Blogs, Wikipedia, policy documents have a relatively higher weighting values [26]. While Mendeley, and CiteULike are shown in the report, they do not contribute to the total score.

**Searching the altmetric system**

The search of the altmetric system was conducted on the same day. The scores were identified using the Altmetric bookmarklet provided by the company [27]. In summary, the articles were searched on PubMed database (the PMID or DOI are essential for triggering the altmetric bookmarklet to function). By clicking on the LinkOut link, we identified the publisher webpage hosting the original article and by clicking the altmetric bookmarklet application, we can check the attention records for the article. The altmetric attention score and donut help in identifying the relative quantity and the type of attention received by a published article. The meaning of the colours included in altmetric donut is explained in this link [28]. The articles
with a grey donut and question mark in the centre indicate that they have not yet received attention across the sources of altmetric tract and have no scores. Some of these articles may have DOI or PMID numbers.

**Statistical Analysis**

All analyses were conducted using SPSS Software (IBM SPSS Statistics Premium version 22.0 for Mac OS-SPSS Inc., Chicago, IL, USA) and the results were reported at total, mean, median, IQR, and percentage. Pearson’s correlation coefficient (r) was calculated to determine if the high citation numbers obtained were related to the age of the article. Other correlations were between the number of citations and the number of authors, the percentage of subgroups in authorship, the number of institutes, the number of countries involved, the number of grants received, and the JIF of the journals in which articles were published. The inter-rater agreement between evaluators was calculated using the Fleiss kappa scale [29].

**Results**

**Top-Cited Papers Identified**

Appendix 1 summarizes the 50 most cited articles in medical professionalism identified by searching the Web of Science database [30-79], out of a total of 3500 articles identified on professionalism. The articles are listed in a descending order from 1 to 50 with the highest absolute citation number is ranked 1 and the article with the lowest citation ranked 50 as per the day of the search. Articles with the same number of citations were ranked on the basis of average citation per year. (e.g., the articles ranked 34 and 35 had the same citation number 97, they were allocated to a ranking order based on the calculated citation per year, 13.86 and
7.46, respectively). Other articles that had the same citation number and were ranked on the basis of their calculated citation per year were articles ranked 36 and 37; 43 and 44; as well as 46 and 47.

Table 1 summarizes the year of publication and article category. The articles were published over 17 years (from 1994 to 2011). During the period from 1994 to 1999, only 7 articles (14%) were published. However, the number increased significantly from 2000 to 2005 making a total of 24 (48%) articles. The number in the years from 2006 to 2011 dropped to 19 (38%). No correlation was found between the citation counts of these papers and the number of years since publication (Pearson correlation (r) = 0.188, p = 0.192).

Table 2 summarizes the distribution of the medical professionalism topics covered in these articles. The articles were published in the following journals: *Academic Medicine* (n=19, 38%), *the Journal of the American Medical Association* (n=9, 18%), *Journal of General Internal Medicine* (n=4, 8%), *Annals of Internal Medicine* (n=4, 8%), *the New England Journal of Medicine* (n=3, 6%), and *Medical Education* (n=3, 6%). It is interesting to note that 24 (48%) articles were published in eight general medicine journal and the remaining were published in four medical education journals and one journal specialized in bioethics. Most journals have high journal impact factors and are on the top of their field (Table 3).

The first author of the top-cited articles was from the United States (n= 37, 74%), Canada (n= 8, 16%), the United Kingdom (n=2, 4%), Germany (n= 1, 2%), Israel (n=1, 2%), and New Zealand (n= 1, 2%).

Table 4 summarises the 26 authors who have published two or more papers in medical professionalism. Of these, five authors were the first authors of two or more papers, ten were
coauthors of two or more papers, and the remaining eleven were the first authors and coauthors of two or more articles. Top authors were Papadakis, M (n=4-first author of all four papers), and Blank, L (n=4- first author of one paper and coauthor of three). Other top authors are shown in Table 4.

The leadership of universities and institutes that have contributed to the creation of these publications were Massachusetts General Hospital and Harvard Medical School, Boston, Massachusetts, the United States; School of Medicine, University of California, San Francisco, San Francisco, the United States; Jefferson Medical College, Philadelphia, the United States, Dalhousie University, Halifax, Nova Scotia, Canada; Mayo Clinic, Rochester, Minnesota, the United States; Department of Community, Health Sciences, St. George’s Hospital Medical School, London, the United Kingdom; McGill University Faculty of Medicine, Montreal, Quebec, Canada; and McMaster University, Hamilton, Ontario, Canada. See Appendix 1 for more detail.

**Characteristics of the Top-Cited Articles**

These articles were created by 252 authors, median 4.0, minimum 1, maximum 19, IQR 4, and the females in authorship were 102, median 2.0, minimum 0, maximum 11, IQR 2. The institutes involved were 168, median 2.0, minimum 1, maximum 17, IQR 3; the countries involved were 67, median 1.0, minimum 1, maximum 9, IQR 0; and the grants/funds received were 35, median 0.0, minimum 0, maximum 8, IQR 1. Significant correlations were found between the number of citations and the 2016-JIF (Pearson correlation (r) = 0.318; p=0.024), and the number of countries (r =0.453; p= 0.001). No significant correlations were found between the number of citations and the number of years since publication (r=0.188,
p = 0.192), the number of authors (r = 0.159; p = 0.270), number of females in authorship (r = -0.343; p = 0.15), the number of institutes involved (r = 249; p = 0.081), or the number of grants received (r = -0.126; p = 0.384).

**The altmetric scores**

The altmetric scores and reports were found for 70% of articles. The total scores were 806, median 5.0, minimum 0.0, maximum 155, IQR 20. No correlation was found between the number of citations and the total altmetric scores (r = 0.064; p = 0.661). Only 38% of the articles had readers on CiteULike (mean 1.6, 95% CI 0.4-2.7, median 0.0, minimum 0.0, maximum 19, IQR 1); while 62% were read Mendeley (mean 72.7, 95% CI 45.2-100.3, median 39.5, minimum 0.0, maximum 499, IQR 120. The coverage of journal articles by Twitter was 54% (mean 7.8, 95% CI 2.7-13.0, median 1.5, minimum 0.0, maximum 117, IQR 10) followed by blogs 38% (mean 1.2, 95% CI 0.6-1.8, median 0.0, minimum 0.0, maximum 7, IQR 1), then policy sources 24% (mean 0.38, 95% CI 0.15-0.61, median 0.0, minimum 0.0, maximum 3, IQR 0.0), then Facebook 20% (mean 0.3, 95% CI 0.07-0.61, median 0.0, minimum 0.0, maximum 6, IQR 0.0). The Wikipedia was the lowest resource. No significant correlation was found between the number of citations and altmetric scores (r = 0.064; p = 0.661). The geographic breakdown showed that United States had the highest share, followed by United Kingdom. Other countries identified for some articles were Canada, Mexico, Spain, Australia, Spain, Chile, Netherlands, Portugal, Japan, Columbia, Italy, France and Brazil.

**Discussion**

The aims of this study were to identify the 50 most cited papers in medical professionalism and compare their characteristics and citation analysis with the altmetric scores. Currently
there is a great interest to examine if there is a relationship between altmetric indicators and citation counts. The question remains can we measure the impact of scientific publications by measuring their social density effects?

The study has identified key topics related to medical professionalism including:
Learning/teaching professionalism and curriculum issues, Professional and unprofessional behaviour/disciplinary actions, Defining and measuring medical professionalism, Response to conflict, social responses, and social environment, Empathy and moral development, Online social networking and professionalism, Quality improvement and evidence-based practices, Role modeling, mentoring and professional clinical practice, and Public roles and medical professionalism. While these topics highlight major issues related to medical professionals, topics related to transition of first-year students from being laypersons to being members of the medical profession, how medical schools change assessment to focus much more on a student’s attitudes and personal development as a professional, not just on his or her knowledge of medicine, as well as strategies to introduce new teaching/learning approaches that facilitate the integration of medical professionalism across the years in the medical curriculum and demonstration of professional behavior in day-to-day practices may be lacking [80].

The study revealed the characteristics of the 50 most cited articles; the following points are worth discussion:
First, the study demonstrated that there is no significant correlation between the citation counts and the number of authors, or the number of female authors. The number of authors and females in authorship varied from one to 19 and from zero to 11, respectively. The two questions that can be raised in this regards; are we expecting an increase in number of
citations as the number of authors increases? And is the gender of authors a factor affecting
citation counts? Several studies indicated that the number of authors or the gender of authors
are not among the factors affecting the citation received by a publication; factors such as
having a higher level of evidence may be more likely to affect citation counts [81].

Although the proportion of women in authorship of original research in the United States in
general has significantly increased in the last four decades and more women are enrolling
Master’s and PhD degrees [82], women still compose a minority of the authors of original
research and there are some differences by subfield [83,84]. Recently, an increased
satisfaction about the proportion of women faculty, especially full professors in academic
medicine, has been reported, suggesting an improvement in the balance at least in this subfield
[85].

Second, the study showed significant correlation between the citation counts and the number
of countries involved, but not the number of institutes. While Figg et al [86] reported that
there is a correlation between the number of authors and the number of times an article is cited
by other researchers, the work of Garcia-Aroca et al [87] showed that publishing in English in
certain journals and collaborating with certain authors and institutes increase the visibility of
the manuscripts published on the subject. Hence it is the quality of collaboration rather than
the absolute number of these parameters. Recently Tanner-Smith and Polanin showed that
studies conducted by more established authors (have higher $h$-indices) and reported in more
prestigious journal outlets are more likely to be cited by other scholars, even after controlling
for various proxies of study quality [88].
Third, the study showed no significant correlation between the number of citations and the number of grants received. This finding is not surprising. Recently it was shown that too many of the United States authors of most influential papers in science do not receive NH funding [89]. Another group of researchers found no association between grant percentile ranking and grant outcome as assessed by number of top-10% articles per dollar million spent [90]. Interestingly, the work of Gok et al [91] showed that funding on its own is not a measure of citation impact but is principally related to funding variety and negatively related with funding intensity. Also there was an inverse relationship between the relative frequency of funding and citation impact.

Fourth, the lack of significant correlation between the number of citations and the number of years since publication may indicate that the higher citations are not due to ageing of articles but possibly due to the new knowledge discussed and the evidence presented by authors to answer challenging questions. In fact the majority of these articles (36, 72%) were published in 2003 to 2011 and the oldest article in the list was published in 1994.

The United States, Canada and the United Kingdom contributed most to these articles. The leadership of universities from these countries in medical professionalism is no surprise, top universities identified from this study were from the United States- Massachusetts General Hospital and Harvard Medical School, Boston, Massachusetts; the School of Medicine, University of California, San Francisco, San Francisco; the Jefferson Medical College, Philadelphia, and from Canada Dalhousie University, Halifax, Nova Scotia, McGill University Faculty of Medicine, Montreal, Quebec, and McMaster University, Hamilton, Ontario, and from the United Kingdom St. George’s Hospital Medical School, London.
Altmetrics have a number of functions including: First, a record of the degree to which people, public and academics/clinicians, engaged with a scholarly publication. Second, a measure of the dissemination of a scholarly work including the geographic and demographic details of those involved in such discussions on social media channels. Third, possibly an indirect measure of influence and impact of scholarly work.

The idea of “altmetrics” or social web metrics was first proposed by Priem and Hemminger [92] and is based on the hypothesis that the analysis of scientific outputs and discussions in social media tools can be used as an alternative to citation bibliometrics created by Garfield [93]. The hypothesis may bring new insight into the understanding of scientific impact and the type of relationship between alternative metrics and citation scores. However, currently there is evidence that the use of social media in promoting and discussing research is low in the research community. It has been reported that 15-25% of scientific publications have some altmetric activities and these activities are observed mostly in recent publications in social sciences, humanities, medical and life sciences [94]. With these limitations in mind, it is clear that altmetrics open new directions in understanding scientific impact of a publication not just through peer-review and citation indices, but through assessing other aspects of impact at society, education, and public domains. However, the instrument is still in the early stages and the scientific communities are still not well prepared for such change.

**Conclusions**

While there was no significant correlation between the number of citations and the number of years since publication, the number of authors, the number of female authors, the number of institutes, or the number of grants received; the correlation between number of citations and the 2016-JIF or the number of countries involved in the study were significant. The number of
females in authorship (40% of total number of authors) highlights the progressive role of females in medical education and the area of medical professionalism. It may be premature to make conclusions about the lack of correlations between the number of citations and the altmetric scores. However, there is not enough evidence to support the notion that altmetric scores can replace bibliometric analysis.
Declarations

Ethical approval was not needed because the article is based on searching the data base of Web of Science and there were no confidential information or human or animal interventions in the study.

Conflicts of Interest

None declared. The authors declare that they have no conflicts of interests

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Authors’ contribution

SAA conceived and designed the study; collected and performed the search of databases, analysis, and interpretation of findings, and drafting the manuscript. SA shared in the search of databases, analysis of findings and critical revision of the manuscript. Both authors approved the manuscript for publication.

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**Glossary**

**Articles** are scientific written composition representing a substantial advance in the understanding of a topic or problem. They raise questions, provide thoughtful, critical analysis and aim at establishing new directions.

**Research papers** original studies making systematic investigations into a problem, using valid and reliable methods in order to establish answers to the research questions made, and come with conclusions. Research methods used may be qualitative, quantitative or mixed methods.

**Editorial materials** are defined as brief articles that may raise questions, provide current status or new developments/advances in the field or structured as a commentary.

**Reviews** are defined as an article reviewing the progress of knowledge in a particular topic, critically analysing the current status of knowledge and presenting an understanding of the subject by discussing related literature. A review should identify gaps in the literature and highlights future directions for further research.
Table 1. The most cited papers in medical professionalism identified by searching the Web of Knowledge, summarized by year of publication and category

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<tr>
<td>Article</td>
<td>2 [59,74]</td>
<td>4 [35,46,60,67]</td>
<td>8 [40,47,49,51,53,61,76,64]</td>
<td>3 [33,65,68]</td>
<td>2 [69,75]</td>
<td>19 (38%)</td>
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<td>Editorial material</td>
<td>1 [44]</td>
<td>1 [57]</td>
<td>1 [31]</td>
<td>1 [58]</td>
<td>4 (08%)</td>
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<td>Research</td>
<td>1 [42]</td>
<td>4 [34,37,66,73]</td>
<td>5 [43,45,48,54,71]</td>
<td>6 [39,41,63,72,77,79]</td>
<td>16 (32%)</td>
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<tr>
<td>Total (%)</td>
<td>1 (2%)</td>
<td>6 (12%)</td>
<td>7 (14%)</td>
<td>17 (34%)</td>
<td>9 (18%)</td>
<td>10 (20%)</td>
<td>50 (100%)</td>
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Table 2 The most cited articles in medical professionalism identified by searching the Web of Knowledge, summarized by category and topic

<table>
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<tr>
<th>Topics in medical professionalism</th>
<th>Category: number of articles [References]</th>
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<tr>
<td></td>
<td>Articles</td>
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<tr>
<td>Defining and measuring medical professionalism</td>
<td>2 [35,47]</td>
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<td>Role modeling, mentoring, and professional clinical practice</td>
<td>1 [40]</td>
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<td>Physician charter and professionalism</td>
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<tr>
<td>Response to conflict, social responses, and social environment</td>
<td>3 [33,46,61]</td>
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<tr>
<td>Professional and unprofessional behavior/disciplinary actions</td>
<td>3 [75,68,74]</td>
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<td>Empathy and moral development</td>
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<tr>
<td>Professional conduct of medical students</td>
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<tr>
<td>Online social networking and professionalism</td>
<td>1 [69]</td>
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<td>Quality improvement and evidence-based practices</td>
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<tr>
<td></td>
<td>19 (38%)</td>
</tr>
</tbody>
</table>
Table 3. The journals that published the top-cited articles in medical professionalism included in this study, the journal impact factor, the number of papers and the reference numbers

<table>
<thead>
<tr>
<th>Journal</th>
<th>2016-Journal Impact Factor</th>
<th>Number of papers published [References]</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Journal of the American Medical Association</em></td>
<td>44.405</td>
<td>9 [30,32,33,39,41,42,64,67,75]</td>
</tr>
<tr>
<td><em>New England Journal of Medicine</em></td>
<td>72.406</td>
<td>3 [34,44,57]</td>
</tr>
<tr>
<td><em>Academic Medicine</em></td>
<td>5.255</td>
<td>19 [35,36,37,38,40,45,46,47,50,52,56,59,60,63,65,68,70,74,77]</td>
</tr>
<tr>
<td><em>Journal of General Internal Medicine</em></td>
<td>3.701</td>
<td>4 [43,48,61,69]</td>
</tr>
<tr>
<td><em>Medical Education</em></td>
<td>4.005</td>
<td>3 [49,66,72]</td>
</tr>
<tr>
<td><em>Health Affairs</em></td>
<td>4.980</td>
<td>1 [51]</td>
</tr>
<tr>
<td><em>Advances in Health Sciences Education Theory and Practices</em></td>
<td>1.852</td>
<td>1 [53]</td>
</tr>
<tr>
<td><em>Annals of Internal Medicine</em></td>
<td>17.135</td>
<td>4 [31,54,71,78]</td>
</tr>
<tr>
<td><em>British Medical Journal</em></td>
<td>20.785</td>
<td>1 [55]</td>
</tr>
<tr>
<td><em>Medical Teacher</em></td>
<td>2.502</td>
<td>2 [58,62]</td>
</tr>
<tr>
<td><em>Canadian Medical Association Journal</em></td>
<td>6.784</td>
<td>1 [73]</td>
</tr>
<tr>
<td><em>American Journal of Bioethics</em></td>
<td>6.434</td>
<td>1 [76]</td>
</tr>
<tr>
<td><em>Archives of Internal Medicine</em></td>
<td>17.333</td>
<td>1 [79]</td>
</tr>
</tbody>
</table>
Table 4. Authors and co-authors of two or more articles of the top-cited articles in medical professionalism identified by searching the Web of Science

<table>
<thead>
<tr>
<th>Author’s name</th>
<th>Number [Reference]</th>
<th>Author’s name</th>
<th>Number [Reference]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First author</td>
<td>Coauthor</td>
<td>First author</td>
</tr>
<tr>
<td>Epstein, RM</td>
<td>2 [30,32]</td>
<td>-</td>
<td>Greysen, SR</td>
</tr>
<tr>
<td>Blank, L</td>
<td>1 [31]</td>
<td>3 [33,56,71]</td>
<td>Kind, T</td>
</tr>
<tr>
<td>Kimball, H</td>
<td>-</td>
<td>2 [31,33]</td>
<td>Mann, KV</td>
</tr>
<tr>
<td>Brennan, TA</td>
<td>1 [33]</td>
<td>1 [64]</td>
<td>Dyrbye, LN</td>
</tr>
<tr>
<td>Rothman, DJ</td>
<td>1 [57]</td>
<td>1 [33]</td>
<td>Thomas, MR</td>
</tr>
<tr>
<td>Blumenthal, D</td>
<td>-</td>
<td>2 [33,54]</td>
<td>Sloan, J</td>
</tr>
<tr>
<td>Papadakis, MA</td>
<td>4 [34,37,71,74]</td>
<td>-</td>
<td>Shanafelt, TD</td>
</tr>
<tr>
<td>Teherani, A</td>
<td>-</td>
<td>2 [34,37]</td>
<td>Holmboe, ES</td>
</tr>
<tr>
<td>Veloski, JJ</td>
<td>1 [56]</td>
<td>1 [34]</td>
<td>Coulehan, J</td>
</tr>
<tr>
<td>Hodgson, CS</td>
<td>-</td>
<td>2 [34,37]</td>
<td>Cruess, RL</td>
</tr>
<tr>
<td>Swick, HM</td>
<td>2 [35,42]</td>
<td>-</td>
<td>Eva, KW</td>
</tr>
<tr>
<td>Levinson, W</td>
<td>-</td>
<td>2 [52,75]</td>
<td>-</td>
</tr>
<tr>
<td>Gruen, RL</td>
<td>1 [64]</td>
<td>1 [54]</td>
<td></td>
</tr>
</tbody>
</table>