

Rheumatoid arthritis: scientific development from a critical point of view

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Received: 20 February 2009 / Accepted: 2 June 2009 / Published online: 23 June 2009
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Abstract Rheumatoid arthritis (RA) is classified as a chronic, progressive, systemic autoimmune disorder leading to inflammation, stiffness, defective position and destruction of joints. Finally a complete loss of mobility and functioning can be the result. The fraction of disability varies strongly, for example, a systematic review shows a 50% disability in a period from first occurrence to disability from 4.5 to 22 years. Scientific efforts focused strongly on therapeutic and diagnostic methods during recent years. So far, there is no scientometric approach of the topic rheumatoid arthritis available although there is an increased need to evaluate quality and quantity of scientific research. Density-equalizing algorithms, scientometric methods and large scale data analysis were

applied to evaluate the quality and quantity of scientific efforts in the field of rheumatoid arthritis. Data were gained from PubMed and ISI-Web. During the period 1901–2007, 78,128 items were published by 129 countries including the USA, UK and Germany being the most productive suppliers, representing 45.7% of all publications. Another 23 countries published more than 100 items. In terms of international cooperation the USA proved to be the most successful partner. “Arthritis and Rheumatism”, “Annals of the Rheumatic Diseases” and the “Journal of Rheumatology” are the most prolific journals. The current study is the first analysis of “rheumatoid arthritis” research activities and output. Our analysis revealed single areas of interest, the most prolific journals, authors and institutions dealing with the topic. Nevertheless, statements concerning the scientific quality should be considered critical due to a bias according to self-citation and co-authorship.

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Keywords Rheumatoid arthritis · Self-citation bias ·
Scientometrics · Autoimmune disorder

Introduction

Rheumatoid arthritis (RA) is classified as a chronic, progressive, systemic autoimmune disorder leading to inflammation, stiffness, defective position and destruction of joints [1–3]. Moreover, a number of other organs are affected by this disease, namely, the lungs (fibrosis of the lungs or Caplan’s syndrome), the skin (rheumatoid nodule or Sweet’s syndrome), the kidneys (renal amyloidosis) or blood vessels and heart (atherosclerosis or endocarditis) [1, 4–6]. Finally a complete loss of mobility and functioning can be the result [7]. Diagnostic methods include blood tests (e.g. rheumatoid factor and ACPA) and X-rays [8]. Diagnostic criteria of the American College of Rheumatology include several other symptoms

and signs such as symmetric arthritis (at least 6 weeks), morning stiffness (>1 h for at least 6 weeks on most of the mornings), arthritis of hand joints (for at least 6 weeks), and soft-tissue swelling (>3 of 14 joint groups for at least 6 weeks) [9–11]. A number of infectious organisms are suspected to trigger RA such as parvovirus B19, rubella, Epstein-Barr virus (EBV), human herpes virus 6 (HHV-6) or mycoplasma [12–15]. The genetic analysis revealed a higher risk of RA in association with HLA-DR4 and PTPN22 [16, 17]. Life-style factors such as type of diet have an influence on the course of this disease. Generally women show a higher occurrence rate. Hormonal factors are discussed to have a negative impact [18–20]. Treatment is focused mainly on analgesia, anti-inflammatory and disease-modifying anti-rheumatic drugs (DMARD) although physical therapy is important as well. Severely affected joints may require joint replacement [21, 22]. Most individuals who are affected by RA feel at least impaired in their daily activities [23]. The fraction of disability varies strongly. A systematic review shows 50% disability in a period between first occurrence and disability ranging from 4.5 to 22 years [24–27]. In recent years enormous efforts have been made to improve therapeutic and diagnostic methods. Nevertheless, there is no scientometric approach to the topic “rheumatoid arthritis” available so far, although there is an increased economic need to evaluate quality and quantity of scientific accomplishments. The aim of the present study was to evaluate the role of RA in using large scale data analysis, scientometric approaches and density-equalizing procedures.

Methods

Data source

Data was retrieved from the Web of Science database (ISI-Web) and from the Medline database (PubMed).

Search strategies

After entering the topic “rheumatoid arthritis” in the search field it was joined with the Boolean operator, such as, AND and OR to approximate the overall number of published items. Further research in the data base was refined using the “analyze” function and the “citation report”.

Time span

The initially analyzed time span included the period from 1900 to 2007, but the first item marked with “rheumatoid arthritis” was not published before 1901. Results from 2008 and 2009 were not included in the analysis because data acquisition is not terminated yet.

Citation quantities

All published items were analyzed with the “citation report” method. Citations per year for all items in the set and the average citations per item in a country-specific manner served as the main parameters. Subsequently, average citations per item rate were restricted to countries that published more than 50 items.

Data categorization

All data files were analyzed by various aspects, for example, the source title, the origin (publishing countries), the most productive journals, subject category, the publication date and the institution. Data were transferred to Excel charts and illustrated in diagrams.

Density-equalizing mapping

Specific calculations based on Gastner and Newman’s algorithms, a recently published method, were applied to visualize the distribution of the overall number of published items and the average citation rate in a country-specific manner. In brief, territories were resized according to a particular variable, namely, the number of published items or the average citation rate [28].

H-index

The H-index serves as a tool to rate and compare a scientist’s quality. The H-index depends similarly on publication numbers and how often these articles have been cited [29].

Impact factor

A journal’s impact factor is defined as the average number of citations in a year given to papers published during the two preceding years [30]. The impact factor can be used to compare the most productive journals with each other.

Analysis of cooperation

To visualize the international cooperation, data of references were gained from ISI-Web as plain text files and analyzed.

Results

Total number of published items

During the period 1901–2007 a total of 78,128 items were published and included in the Web of Science database

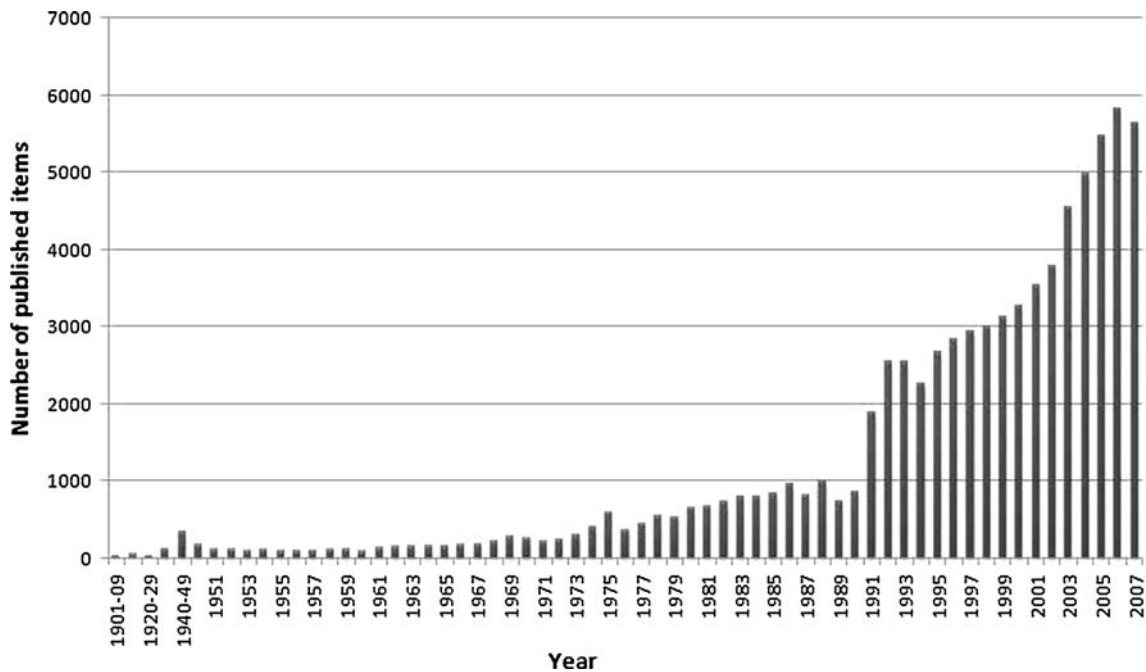


Fig. 1 Published items related to rheumatoid arthritis in the Web of Science database 1900–2007

(Fig. 1). The progress in the number of published items was used as an index of research productivity.

Analysis of origin and cooperation

The 78,128 entries originated from 129 countries including the USA, UK and Germany being the most productive countries, representing 45.7% of all published items (Fig. 2a). In addition, 23 countries have more than 100 published items (Fig. 2b). Analysis regarding the international cooperation illustrates that most of the efforts are concentrated in the USA. Thus, the cooperation between USA and UK (995), USA and Canada (928), USA and Germany (630), and between USA and the Netherlands (565) can be signified as the most productive ones (Fig. 3).

Citation parameters

St. Lucia (135.00), Netherlands Antilles (25.00) and Lesotho (24.00) have the highest citations rate in a country-specific manner (Fig. 4a), whereas analysis of the average citation rate for countries with more than 50 published items illustrated Belgium with the highest rate (22.15), followed by the USA (22.08) and Canada (20.34) (Fig. 4b).

Analysis of assigned publishing journals and the most productive authors

The ten most productive journals dealing with the topic were determined. In this respect “Arthritis and Rheumatism” leads

with 9,858 items and an impact factor of 7.751, followed by the journals “Annals of the Rheumatic Diseases” with 6,279 items (impact factor 5.767) and the “Journal of Rheumatology” with 5,055 items and an impact factor of 2.940 (Fig. 5a). Furthermore, the ten most productive authors and their H-index were detected (Fig. 6b). “Breedveld FC” is the most productive author with 602 items. “Emery P” (600 items) and “Dijkmans BAC” (367 items) followed on the second and third place. The H-index shows a different distribution. “Wolfe F” holds the highest H-index (63), followed by “Breedveld FC” (58) and “Pincus T” (53) (Fig. 5b).

Analysis of assigned subject categories

The subject area “Rheumatology” represented most published items (35,085) in respect to RA. Moreover, “Medicine, General and Internal” (8,155 items) and “Immunology” (7,722 items) were placed second and third. The total number of published items of these subject categories encompassed 65.2% of all published items (Fig. 6a). In addition, analysis of the most productive subject categories of the ten most productive authors revealed a similar distribution. “Rheumatology” (2,824 items) ranked first, followed by “Immunology” (149) and “Medicine, General and Internal” (129) (Fig. 6b).

Analysis of assigned institutions

The most productive institutions were the “Harvard University” (1,102 items), the “University Texas” (903 items) and

Fig. 2 a Density-equalizing map illustrating the number of publications in each particular country. The area of each country was scaled in proportion to its total number of publications regarding rheumatoid arthritis. Study period 1900–2007. **b** Ranking of country total number of published items related to rheumatoid arthritis. Threshold of >50 published items. Study period 1900–2007

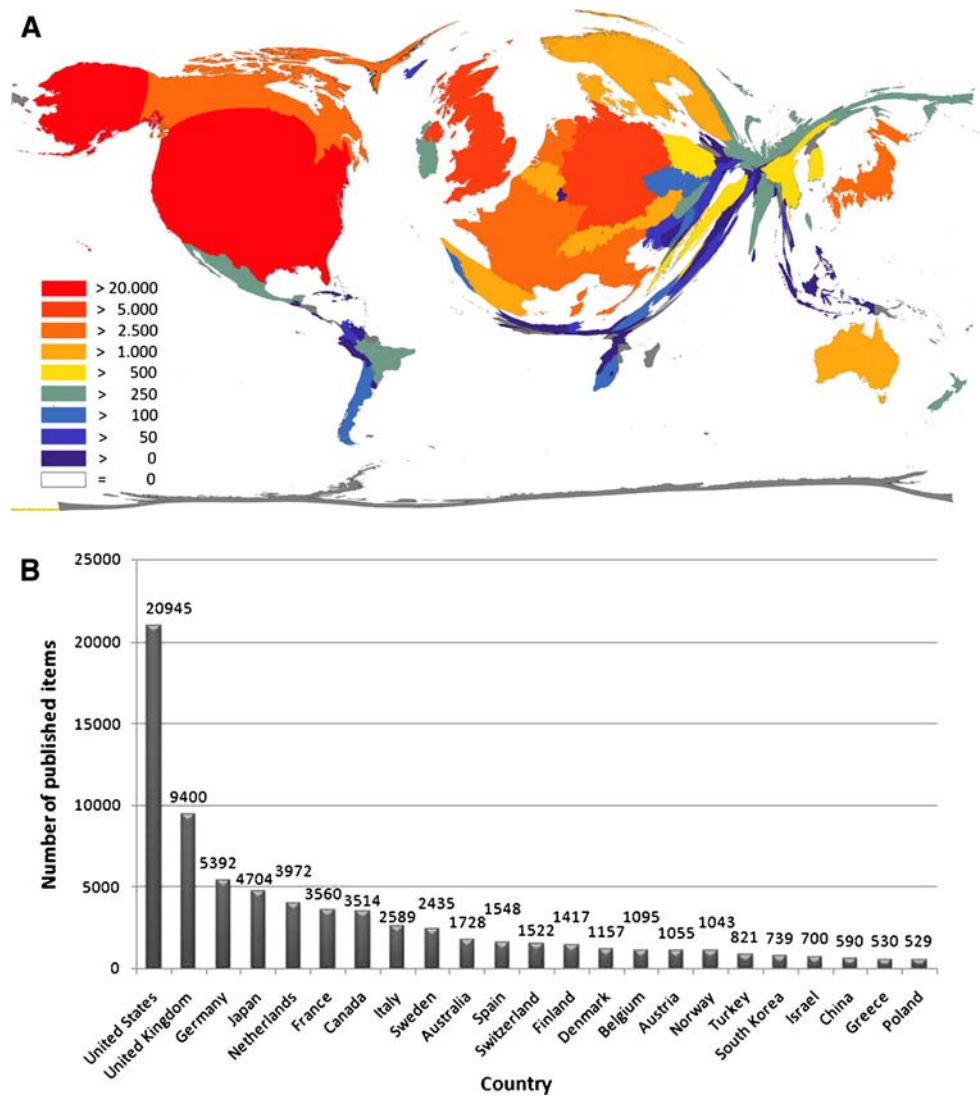


Fig. 3 Analysis of the international cooperation. Threshold >100 cooperations

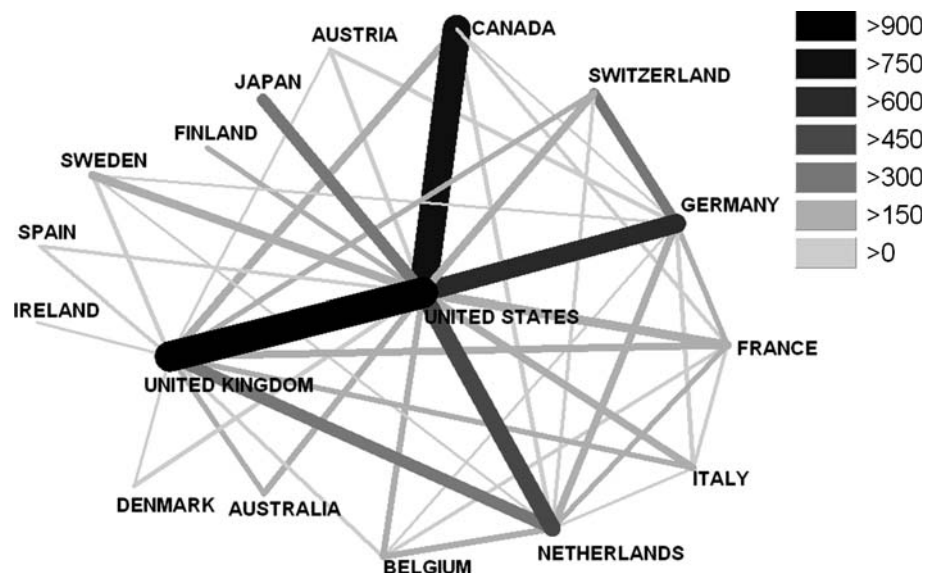
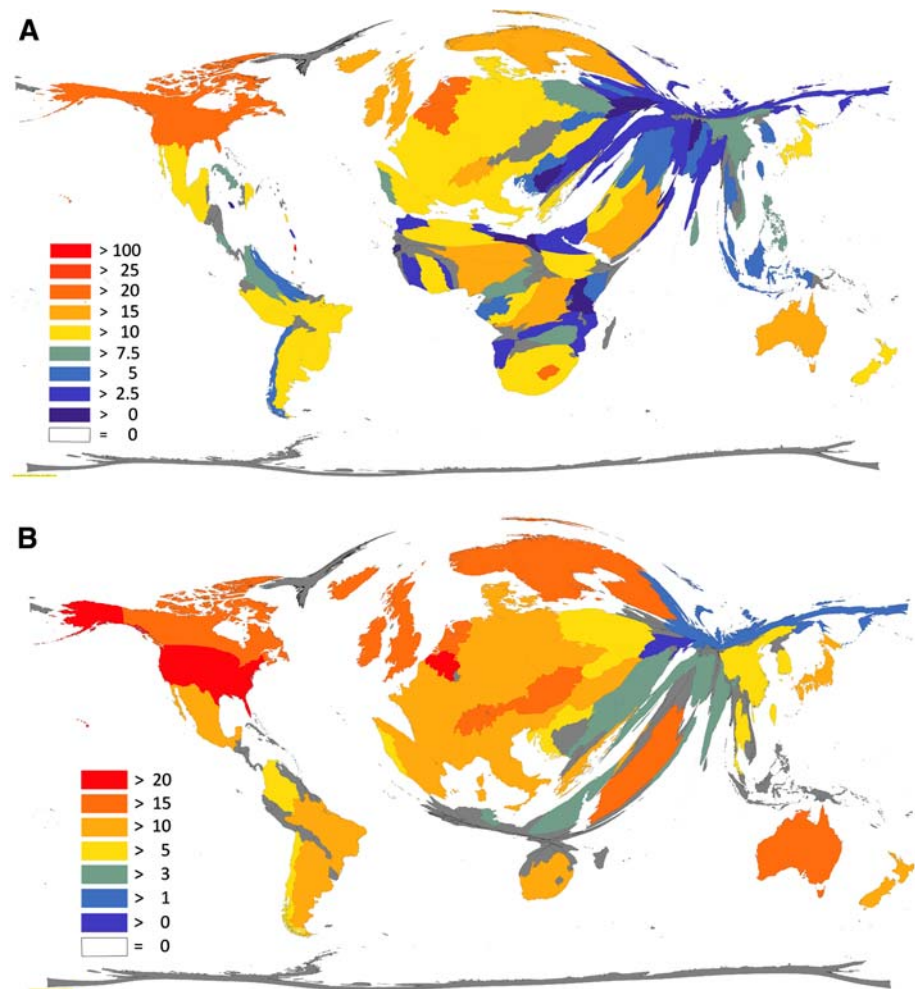


Fig. 4 a Average citations per item rate in each particular country of the 20 countries with the highest rate. Study period 1900–2007. **b** Density-equalizing map showing the average citations per item in each particular country. Threshold excludes countries with <50 published items. The area of each country was scaled in proportion to its average citations per item rate. Study period 1900–2007



the “University Toronto” (851 items). Regarding the origin of these institutions in a country specific manner, eight of them are non-US American (Fig. 7a), located in Canada, UK, Sweden, Finland, Netherlands and Japan (Fig. 7a). Eight of the ten most productive institutions of the ten most productive authors are of non-US American origin (Fig. 7b), whereas four are located in The Netherlands, but we assume that the University of Leiden is included three times with different labels.

Discussion

The present study was carried out to evaluate qualitative and quantitative aspects of research in the field of “rheumatoid arthritis”. Mean of scientometric approaches, density-equalizing procedures and large scale data analysis were used.

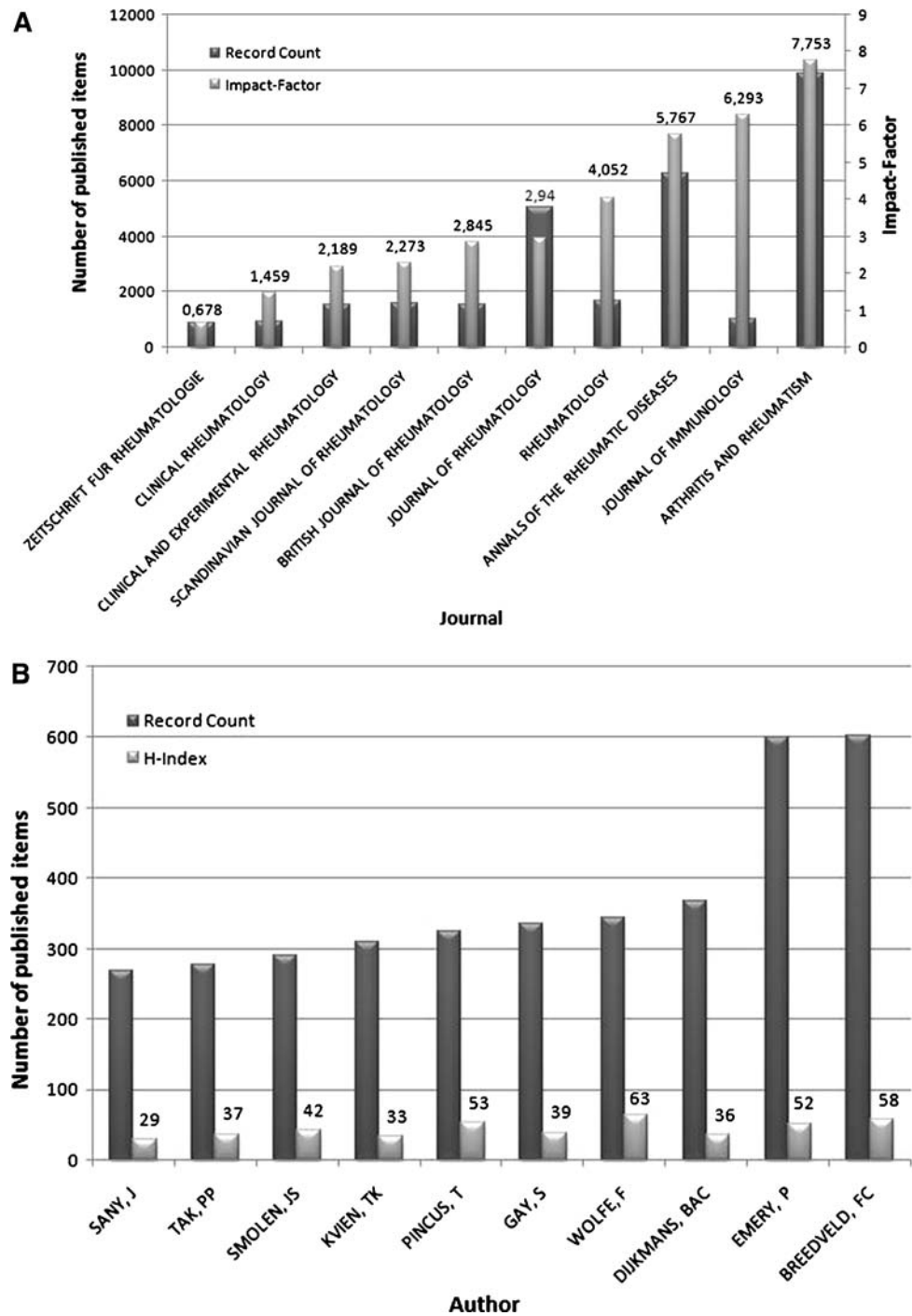
An increasing interest in the field of “rheumatoid arthritis” reflected by the number of scientific publications was detected since 1990. Further data analysis in a country-specific manner revealed that the USA, UK and Germany are

maintaining leading positions. Collaboration analysis illustrates different results, for example, Canada revealed nearly the same number of productive collaborations as the USA. Furthermore, some countries collaborate on a disproportionately low level in comparison with their number of published items (e.g. Japan) while other countries show the exact opposite results (e.g. The Netherlands).

International studies imply normally more citations than studies on a national level. Furthermore, important scientific input leads to increasing numbers of citations and cooperation [30–34]. The Netherlands is a remarkable example of this tendency. As a country which collaborates productively, it is of more scientific interest than countries (e.g. Japan) that published more items, but are less cooperative suppliers.

Confirming this supposition, the average citation rate in a country-specific manner was determined. By using the average citations of items per country, it occurred that the average citation rate of countries with a relatively small amount of published items appeared reasonably high. Thus, a threshold of at least 50 published items was selected for representative results. Moreover, restricted analysis showed

Fig. 5 a Top ten ranking of sources by the number of published and their impact factor items during the period 1900–2007. **b** Ten most productive authors and their H-index in the period 1900–2007



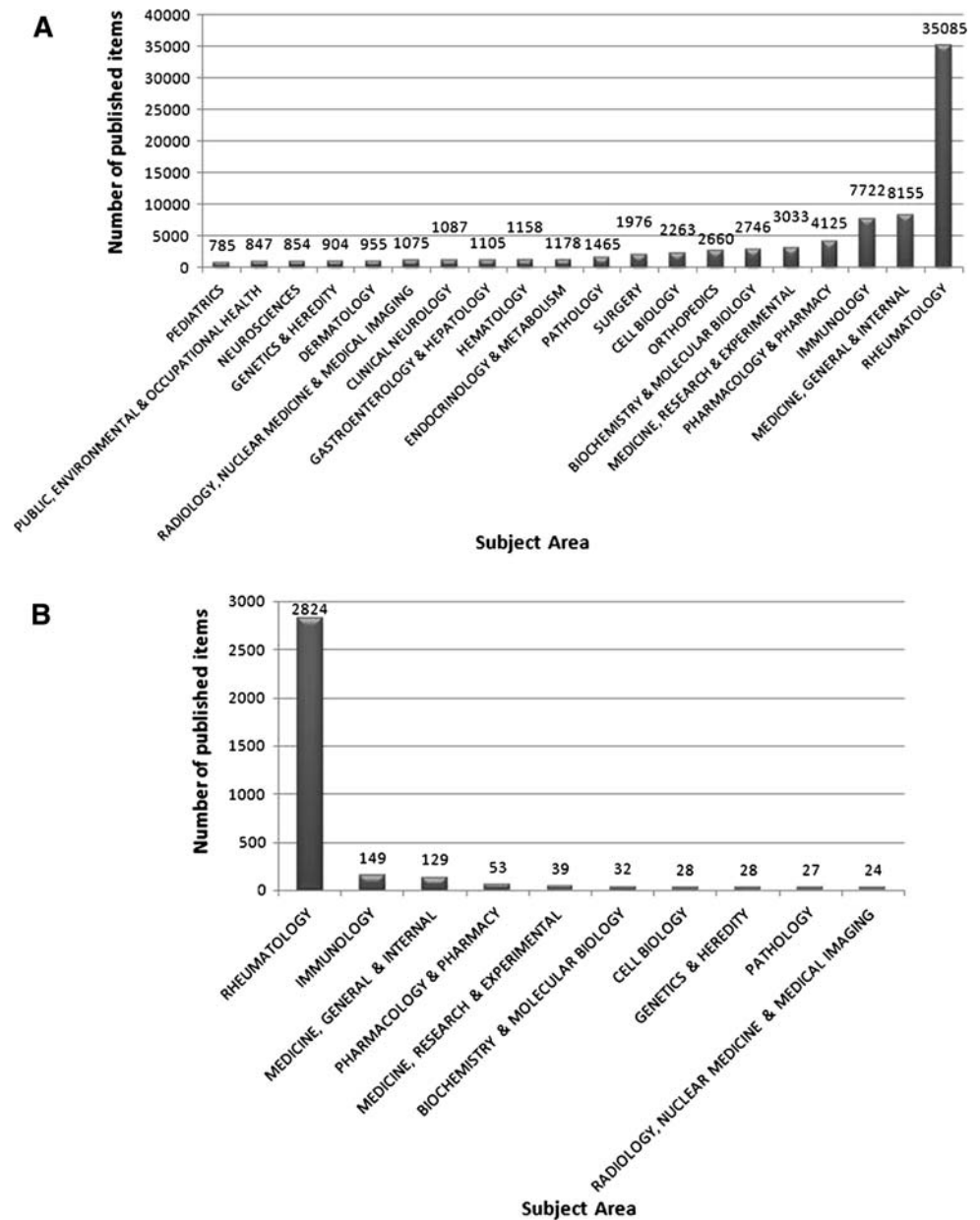
the USA and Belgium possessing the highest rate. Further analysis revealed disproportional high self-citation behavior in these countries leading to disproportional high citation rates [33].

Analysis of assigned institutions disclosed US Americas leading position. Surprisingly regarding the origin of the most productive authors it was revealed that most of them are of non-US American origin. These results implicated the suggestion that non-US-American scientists combine more

co-authorships which distorts the results [35]. Therefore the ratio of first-authorships and co-authorship was analyzed for different authors. Nevertheless, co-authorship bias was not revealed to be the reason for these results. We suppose that the non-US-American institution structure makes it easier to support and promote single and very exceptional authors.

To compare the publishing journals quantity with its quality, Impact-Factor was used as a parameter for scientific quality of the publishing journal. Moreover, “Arthritis and

Fig. 6 a Top 20 rankings of the most productive institutions during the period 1900–2007. **b** Ten most productive institutions of the ten most productive authors. Study period 1900–2007



Rheumatism” and “Annals of the Rheumatic Diseases” combine these parameters the best way. Thus it can be defined as the most prolific journals.

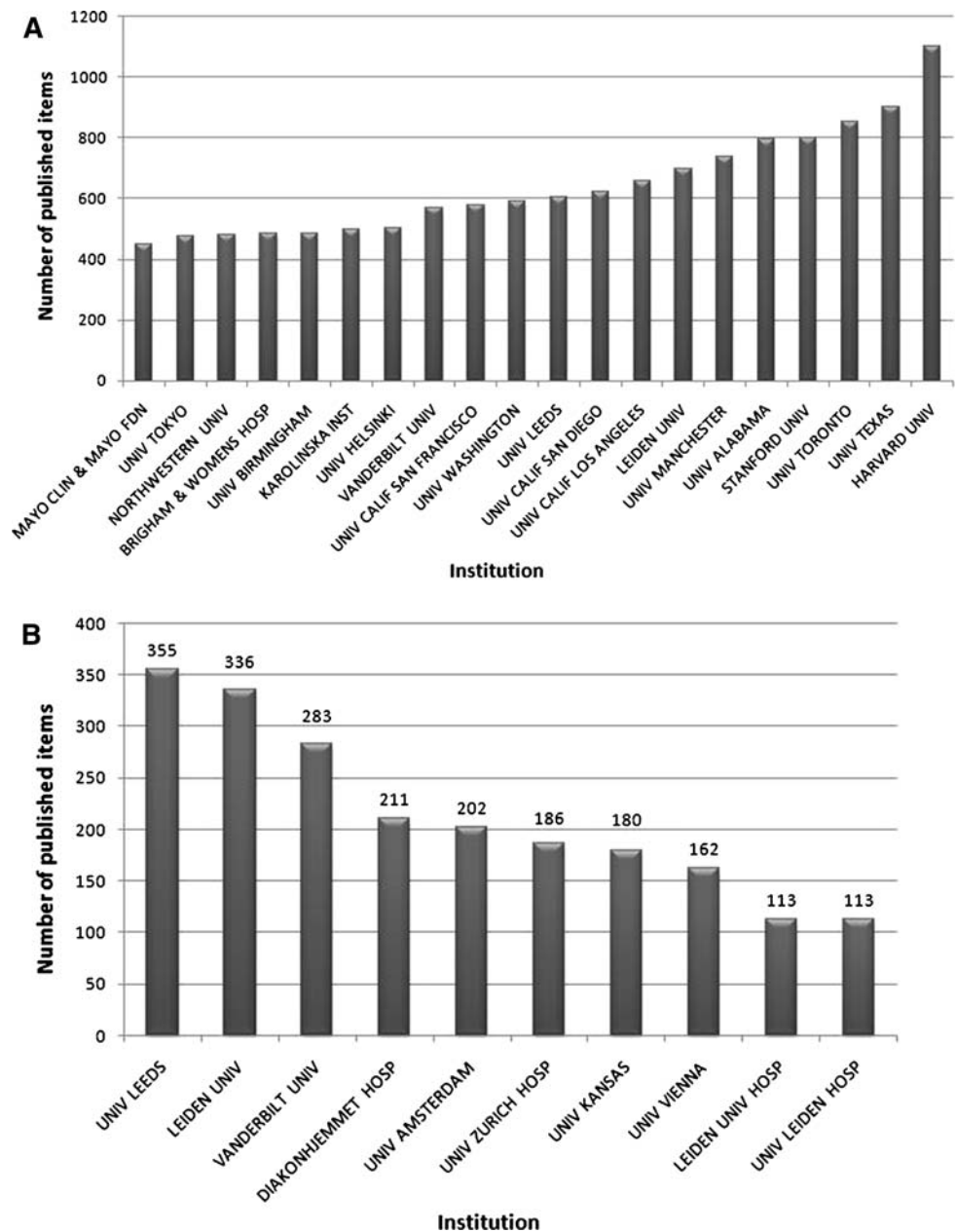
Acquiring the data from ISI-Web reveals a systematic failure by mapping the publications to their country of origin. Moreover, publications with origins in England, Northern Ireland, Wales and Scotland were summarized as United Kingdom (UK). Papers from “West Germany”, “Fed Rep Ger”, “Ger Dem Rep” and “Bundes Republik” are subsumed to “Germany”. Published items from other former countries, such as, “Yugoslavia”, “Czechoslovakia” and the “USSR” were examined according to their university of origin and reassigned to the current country they belong now. In this respect, publications from “Czechoslovakia” were assigned to either “Slovakia” or “Czech

Republic”. The same procedure was applied for studies from the former “Yugoslavia” which includes Montenegro, Bosnia and Herzegovina, Croatia, Slovenia, former Yugoslav Republic of Macedonia (FYROM), and Serbia. Publications from the former “USSR” were assigned to White Russia, the Ukraine, Uzbekistan, Kazakhstan, Georgia, Azerbaijan, Lithuania, Moldova, Latvia, Kyrgyzstan, Armenia, Turkmenistan, Estonia, Tajikistan, or Russia.

Conclusion

The present study represents the first detailed scientometric analysis of research quality and quantity on rheumatoid arthritis. The data show increasing interest and research

Fig. 7 a Top 20 list of assigned categories of published items related to rheumatoid arthritis. Study period 1900–2007. **b** Ten most productive subject categories of the ten most productive authors. Study period 1900–2007



productivity since 1990. The majority of data originates from the USA, UK and Germany. The USA and Belgium take a lead in citation per item rankings. Analysis revealed single areas of interest, the most prolific journals, authors, and institutions dealing with the topic. Nevertheless, statements concerning the scientific quality should be considered critical due to bias of self-citation and co-authorship.

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