New quality and quantity indices in science (NewQIS): results of the first decade—project progress review

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Received: 3 April 2019 / Published online: 13 July 2019
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Abstract
Strategies employing information science and scientometric approaches were introduced to science policy and management over the past decades. As a rapidly evolving field, new bibliometric parameters are proposed and discussed continuously and the fields also benefits from the introduction of novel visualization techniques. The present article summarizes the experiences with a platform that combines geographical mapping with scientometrics. It was established between 2005 and 2008 at the Charité in Berlin and termed “New Quality and Quantity Indices in Science” (NewQIS), consisting of the integration of common scientometric parameters such as the h-index and novel visualization techniques including density equalizing mapping. NewQIS was used to assess socio-economic important fields of medicine and sciences. Within NewQIS studies, research activities, citation patterns and their relation to socio-economic figures were analyzed with regard to time periods, countries, continents or even single cities. Within the decade after its establishment, more than 80 NewQIS articles were peer-reviewed and published. Being a non-funded low budget project, it was used by many medical students to conduct their MD thesis. The narrow technical frame led to the chance of a comparison of research output between different fields of science. This article summarizes NewQIS 1.0 activities, discusses its limits and gives a look into the future of NewQIS 2.0 with a target of 200 evaluated entities of the biomedical field of sciences.

Keywords Scientometrics · Bibliometrics · Spatiotemporal analyses · Space–time geographies · Spatial analyses · Geographic cartography · Choropleth mapping

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Introduction

Academic science is big business and big money. Billions of US-dollars (USD), Euros and other currencies are channeled into academic science every year. As a matter of fact, the decision makers—politicians and career officials—want to know about the fate of funding: Did it work? What was done? How much was done? Who did it? Who did the most?

In order to answer these questions, the field of scientometrics and bibliometric offer convenient but debated benchmarking parameters including the impact factor of a scientific journal. Since the journal impact factor is a very superficial measure with no direct relation to the quality of a single scientific work (Carey 2016; Casadevall and Fang 2014) but only providing information about the performance of a specific journal over a relatively short term, other more sophisticated parameters were developed such as the Hirsch (H) index (Hirsch 2005, 2007). They also include a count of the individual citations that a scientific article receives. However, also the H-index is debatable and should not to be used for any purpose (Bertoli-Barsotti and Lando 2017a, b; Bornmann and Leydesdorff 2018). In this respect, experts in the field have coined the expression of amateur bibliometricians describing the uncritical use of bibliometric tools (Bornmann and Leydesdorff 2014).

With these benchmarking options at hand, other questions arise for decision makers: Can we allocate the funding towards a direction that those who did most—get more funding in order to increase their productivity? To which extend can we do so? Is there a ceiling effect? I.e. by which extend is the total (not relative) productivity increased, if we allocate 2 staff positions to a research group which consist of 2 scientists (making a total of 4 scientists then) in comparison to the allocation of 2 staff positions to a group consisting of 20 scientists or of 50 scientists (making it 22 or 52, respectively). Measured in citations? Or in accumulated impact factors or whatsoever? These questions are linked to the so called Matthew effect (Merton 1968): Those who have most get even more. When counting, measuring and benchmarking are done by the use of superficial parameters in an uncritical way by amateur bibliometricians, and (intramural and extramural) funding is allocated on the basis of who performs best in those superficial counts (i.e. total accumulated impact factor count) these questions critically target freedom of research: Scientists or fields who do not produce measurable amounts of superficial parameters such as accumulated journal impact factors will suffer (Lowy 1997).

Further to the question of funding allocation, also career opportunities are critically dependent on bibliometric benchmarking processes and it is common (but critically debated) law: publish or perish (in high impact factor journals) (Jokstad 2016; Publish or perish 2015; Bergquist et al. 2018). Taking these aspects into account, it is obvious that scientometric markers need to be used only with great caution. They should not be easily used to compare scientists of different ages and different fields, institutions or areas with the purpose to cut off funding since research should only be interpreted for quality on the individual level of a published piece of work.

Still, bibliometric parameters can be used to assess gross information contents and evolution of scientific fields over longer periods of time.

It was exactly this purpose when in the years 2005–2009 a new project was started at the Charité in Berlin (Borger et al. 2008; Groneberg-Kloft et al. 2008a, b, 2009a, d, e): A platform termed NewQIS (1.0) was constructed to establish a new approach to visualize research quantity and quality indices (Groneberg-Kloft et al. 2009b, c). NewQIS 1.0 should be used to assess research activities for (1) distinct areas of science, for (2) single institutions, for (3) single countries, or for (4) single time periods (Fig. 1).
The platform was intended to be a sound basis for future NewQIS studies in all areas of medicine and science. In the following, we (a) briefly summarize the technical basis, and (b) present an overview of the studies and MD theses which were performed on the basis of NewQIS.

**Technical platform**

One important aspect of NewQIS 1.0 was to establish a unified technical platform that enables researchers from different fields of science to be able to assess their area of interest. Therefore, a study panel was formed that decided upon the feasibility of the proposed area. The usual applicants were medical students who—in their duty to conduct an MD thesis—submitted search topics to the study panel. After review and affirmation, the NewQIS analysis were performed and raw data was transferred to the applicants for their purpose.

**Data acquisition**

In NewQIS studies, data is usually retrieved from the Web of Science (WoS) database, i.e. (Kusma et al. 2009). The reason to choose WoS was the ability to perform a citation analysis. This was not possible with PubMed data files.

Depending on the topic of the NewQIS study, the search terms that are entered in the search field consist of various terms which are linked together with Boolean operators such as “AND”, “OR”, “NOT”, i.e. (Glynn et al. 2010).

Depending on the date of the research, the amount of publications and the focus of the research, the evaluation time span covers periods from 1900 until today. Usually, the year in which the NewQIS project is performed, is left out because of incomplete data acquisitions for that given year, i.e. (Al-Mutawakel et al. 2010).
Parameters

The large majority of NewQIS projects focus on a single field of medicine such as a disease and put a focus on the global landscape of research on this particular disease. Thus, the following parameters are usually analyzed (Fig. 1).

Quantity parameters: Productivity

- Total number of published items (i.e. Scutaru et al. 2010b)
- Country specific number of publishes items (i.e. Vitzthum et al. 2010a)

(Semi-)qualitative parameters: Usually, high quality research is characterized by a high number of citations. Therefore, the following citation parameters were also analyzed in the NewQIS projects:

- Total number of citations
- Total number of citations per country
- Country-specific h index
- Country-specific average citation rate per article

Cooperation parameters: A key instrument of NewQIS is to visualize different levels of collaboration. This includes either collaborations between single scientists, countries or institutions. The field of RSV (respiratory syncytial virus) research can give an example how this is achieved: After having identified all relevant RSV-associated publications, the collaborative studies were related to their countries of origin. Publications with two or more authors affiliated to the same country were counted only once for the total number of collaborations of this particular country (Bruggmann et al. 2017c). If an author had two affiliations, these were counted for every country mentioned in the affiliations. Connecting vectors visualized these co-operations; their width and shade of grey reflected the number of joint publications (Bruggmann et al. 2017c). Figure 2 illustrates international collaborations for RSV research.

Visualization

The above listed parameters can also be found in other publications using other approaches (Burak Atci et al. 2019; Ekundayo and Okoh 2018). A specific purpose of NewQIS was to combine these bibliometric parameters with visualization techniques in order to provide a picture of the global landscape of different research aspects. Among different available techniques, density-equalizing map projections (DEMP) were chosen. As elegantly described by Gastner and Newman, map makers searched for a long a way to generate cartograms, in which the sizes of countries appear in proportion to a chosen parameter such as their population (Gastner and Newman 2004). For the purpose of NewQIS, these maps could be used to visualize research activities. As stated by Gastner and Newman, in order to scale countries and still have them properly fit together, they need to be distorted, causing difficulties to read them. In 2004, a new method was proposed which was integrated to the NewQIS platform. With DEMP being a part of NewQIS, the territories of countries were re-sized according to a particular variable, i.e. in proportion to the countries’
Fig. 2 International collaborations for RSV research. International cooperations on RSV research (threshold > 2 cooperations). Numbers in brackets report the number of publications in total/collaborative publications. https://bmjopen.bmj.com/content/7/7/e013615.long, Data from Bruggmann et al. (2017c)

total number of published items regarding to a specific disease. Figure 3 shows examples of DEMPs published within NewQIS studies over the past decade. The distorted global landscape is usually characterized by a dominating USA and an enlarged European area as depicted in Fig. 3a for pulmonary hypertension research output (Gotting et al. 2017). However, there are also research areas in which also countries from other continental regions appear enlarged. This can be seen for snakebite envenoming research for Brazil as shown in Fig. 3b (Groneberg et al. 2016c). China—a rising star in many areas of science—does also appear in some NewQIS assessments prominently as shown for ovarian cancer research in Fig. 3c (Bruggmann et al. 2017d). Concerning Asian countries, a previous assessment of 5527,558 articles has indicated that Asian countries have largely different research focuses in comparison to Western countries (Groneberg-Kloft et al. 2008b). In order to assess changes over the time, spatiotemporal analyses can also be performed by merging to a video consisting of different density-equalizing mapping (Groneberg-Kloft et al. 2009e).

Topics of NewQIS

Structured MD thesis program

The original concept of NewQIS was a low budget intramural platform which was established without major external funding. In order to be able to assess numerous fields of medicine, medical students were enabled to conduct their MD thesis within the NewQIS platform. The highly structured boundaries of the platform also served as a quality control
Fig. 3  Density equalizing map projections (DEMP). a DEMP for pulmonary hypertension research output. Data from Gotting et al. (2017). b DEMP for snakebite envenoming research output. Data from Groneberg et al. (2016c). c DEMP exemplifying prominent Chinese research activities in ovarian cancer research. Data from Bruggmann et al. (2017d)
for the results of the thesis projects making scientific misconduct very difficult (since there was no possibility for the students to manipulate the algorithms applied by the platform).

Since 2009, nearly 80 theses were completed using the methodology of the platform making NewQIS one of the most successful structured thesis programs in Germany. As tutors/mentors of the theses, seven associate/full professors served so far. Also, two technical tutors were present to oversee calculations and data management. Table 1 lists the medical thesis topics.

**Scientific publications**

Since 2008, more than 80 studies using the NewQIS platform were published after peer review. The majority of them based on medical thesis projects with the MD students being first authors in case of writing the manuscripts or co-authors of the scientific studies. The topics ranged from infectious diseases, infectious agents, to cancers, neurological or psychiatric disorders, lung diseases or other diseases. Apart from diseases, they also encompassed i.e. public health issues including tobacco control, medical procedures or techniques. In total, more than 1.6 million published articles related to specific search terms were analyzed for the above listed parameters. Table 2 provides an overview of the different NewQIS articles.

**Limitations of NewQIS**

There are numerous limitations present in every NewQIS-based study:

1. As with every other bibliometric approach, also NewQIS is limited to the data base it uses. Although producing global landscapes of research, it should never be forgotten that these pictures only delineate the research output which can be found in a specific data base (i.e. Web of Science) with a specific search term. Thus, all research not listed in the WoS and all research excluded by the search term (no search term can be absolutely perfect) is not included in the global landscape. This needs to be taken into account carefully when NewQIS results are interpreted. Especially the language bias constitutes an important problem: journals published in English have a higher chance of getting included to the data bases (Nieminen and Isohanni 1999). Thus, non-English speaking countries are underrepresented concerning their research activities and important but regional data such as regional epidemiologic data is not identified (Pleger et al. 2014).

2. A further limitation that needs to be addressed is the above Matthew effect mentioned above: Communication systems in science are directed towards a reward of highly productive and renowned scientists and institutions. This leads to a pyramidal citation scheme (Merton 1968; Pleger et al. 2014).

3. The so-called (semi-)qualitative indicators that are used in NewQIS are parameters such as the total citations, citation rate, country-specific h-index. They need to be interpreted very carefully. As already earlier critically discussed, they are not real measures for the quality of individual research (Pleger et al. 2014). In this respect, a recent study addressed the question if methodological quality and completeness of reporting are associated with citation-based measures of publication impact (Mackinnon et al. 2018). The authors performed a secondary analysis of a systematic review of dementia biomarker studies. They reported that citation rates and 5-year journal impact factors
Table 1: Medical thesis projects that applied the structured NewQIS program

| No. | Place of thesis | Year of exam | Topic of MD thesis | Analysis interval | References                  |
|-----|-----------------|--------------|--------------------|-------------------|----------------------------|
| 1.  | Frankfurt       | 2019         | Tunisia            | 1900–2013         | Fuchs (2019)               |
| 2.  | Frankfurt       | 2018         | Immigration        | 1900–2016         | Trost (2018)               |
| 3.  | Frankfurt       | 2018         | Cervical cancer    | 1900–2015         | Quinkert (2018)            |
| 4.  | Frankfurt       | 2018         | Ovarian carcinoma  | 1900–2014         | Pulch (2018)               |
| 5.  | Frankfurt       | 2018         | Noise              | 1900–2014         | Brich (2017)               |
| 6.  | Frankfurt       | 2018         | Needle stick injury| 1900–2014         | Braumann (2017)            |
| 7.  | Frankfurt       | 2018         | Jaw palate clefts  | 1900–2014         | Mierke (2018)              |
| 8.  | Frankfurt       | 2018         | Child abuse        | 1900–2014         | Wolf (2018)                |
| 9.  | Frankfurt       | 2018         | Melanoma           | 1900–2014         | Scholz (2018)              |
| 10. | Frankfurt       | 2018         | Rotavirus          | 1900–2013         | Köster (2018)              |
| 11. | Frankfurt       | 2018         | Caesarean section  | 1900–2013         | Löhrlein (2018)            |
| 12. | Frankfurt       | 2018         | Caries             | 1900–2012         | Kröber (2018)              |
| 13. | Frankfurt       | 2018         | Tuberculosis       | 1900–2012         | Weber (2018)               |
| 14. | Frankfurt       | 2018         | Tonsillectomy      | 1900–2014         | Neuenfeldt (2018)          |
| 15. | Frankfurt       | 2018         | Schizophrenia      | 1900–2015         | Lammer (2018)              |
| 16. | Frankfurt       | 2018         | Gestational diabetes| 1900–2012       | Richter (2018)             |
| 17. | Frankfurt       | 2017         | Pancreatic carcinoma| 1900–2013     | Krempel (2017)             |
| 18. | Frankfurt       | 2017         | Osteoporosis       | 1900–2012         | Mülle (2017)               |
| 19. | Frankfurt       | 2017         | Human papilloma virus| 1900–2009   | Kayser (2017)              |
| 20. | Frankfurt       | 2017         | Cholera            | 1900–2009         | Mühlbach (2017)            |
| 21. | Frankfurt       | 2016         | Psychiatric journals| 1920–2012     | Abberger (2016)            |
| 22. | Frankfurt       | 2016         | Gastroenterological journals| 1945–2012 | Schäfer (2016)            |
| 23. | Frankfurt       | 2016         | Public Health      | 1912–2012         | D. Hoffmann (2016)         |
| 24. | Frankfurt       | 2016         | Toxoplasmosis      | 1900–2012         | Handl (2016)               |
| 25. | Frankfurt       | 2015         | Aortic aneurysm    | 1900–2010         | Ofosu (2015)               |
| 26. | Berlin          | 2015         | Depression, suicide, cannabis, bipolar disorder| 1900–2008 | Vogelzang (2015)          |
| 27. | Frankfurt       | 2014         | Yellow fever       | 1900–2012         | Bundschuh (2013)           |
| No. | Place of thesis | Year of exam | Topic of MD thesis | Analysis interval | References |
|-----|----------------|--------------|--------------------|------------------|------------|
| 28. | Frankfurt      | 2014         | Smoking and pregnancy | 1900–2005        | Mund (2013) |
| 29. | Frankfurt      | 2014         | Propofol           | 1977–2009        | W. Weiland (2014) |
| 30. | Frankfurt      | 2014         | Extrinsic allergic alveolitis | 1900–2007        | Walger (2014) |
| 31. | Frankfurt      | 2013         | Hepatitis B        | 1900–2010        | Schmidt (2013) |
| 32. | Frankfurt      | 2013         | Osteomyelitis      | 1900–2009        | Schwartzmann (2013) |
| 33. | Frankfurt      | 2013         | Passive smoking    | 1900–2009        | Jacobus (2013) |
| 34. | Frankfurt      | 2013         | Poliomyelitis      | 1900–2009        | Drews (2012) |
| 35. | Frankfurt      | 2013         | Dental implants    | 1900–2010        | Albrecht (2013) |
| 36. | Frankfurt      | 2013         | Influenza          | 1900–2009        | Fricke (2011) |
| 37. | Berlin         | 2012         | Diabetic retinopathy | 1900–2008        | Währlich (2012) |
| 38. | Berlin         | 2012         | Neurologic and psychiatric rehabilitation | 1900–2009 | Hoffmann–Roe (2012) |
| 39. | Frankfurt      | 2012         | MRI-Scan           | 1981–2006        | Schwarz (2012) |
| 40. | Berlin         | 2012         | Pulmonary hypertension | 1900–2007       | Göttin (2012) |
| 41. | Frankfurt      | 2012         | Allergic rhinitis  | 1900–2007        | Wende (2012) |
| 42. | Frankfurt      | 2012         | Sarcoidosis        | 1900–2008        | Kirchdörfer (2012) |
| 43. | Berlin         | 2011         | Bacterial meningitis | 1900–2007       | Pfeffer (2011) |
| 44. | Berlin         | 2011         | Erythropoietin     | 1900–2007        | Schöffel (2011) |
| 45. | Berlin         | 2011         | Bladder cancer     | 1909–2007        | Domnitz (2011) |
| 46. | Berlin         | 2011         | Borrelia burgdorferi | 1900–2008   | Scholz (2011) |
| 47. | Frankfurt      | 2011         | Dengue virus infections | 1900–2007  | Müller (2011) |
| 48. | Hannover       | 2011         | Orthopedic diseases | 1900–2008        | Vitzthum (2011) |
| 49. | Berlin         | 2011         | Glioblastoma multiforme | 1900–2008  | Addicks (2011a) |
| 50. | Berlin         | 2011         | Infectious endocarditis | 1900–2008  | Berkholz (2011) |
| 51. | Berlin         | 2011         | Obesity            | 1900–2009        | Franke (2011) |
| 52. | Berlin         | 2011         | Air pollution, particulate matter and sulphur dioxide | 1955–2006 | Zell (2011) |
| 53. | Berlin         | 2011         | Methicillin-resistant staphylococcus aureus (MRSA) | 1961–2007     | Addicks (2011b) |
| No. | Place of thesis | Year of exam | Topic of MD thesis | Analysis interval | References |
|-----|----------------|--------------|--------------------|------------------|------------|
| 54. | Berlin         | 2011         | Barotrauma         | 1900–2008        | Garnew (2011) |
| 55. | Berlin         | 2011         | M Alzheimer        | 1985–2006        | Tropp (2011)  |
| 56. | Berlin         | 2011         | Varicella zoster virus | 1900–2008  | Busch (2011)  |
| 57. | Berlin         | 2011         | Resuscitation      | 1900–2007        | Weiland (2011)|
| 58. | Berlin         | 2011         | Cystic fibrosis    | 1900–2009        | Falahkohan (2011) |
| 59. | Berlin         | 2010         | Body mass index    | 1900–2008        | Bohlen (2010) |
| 60. | Berlin         | 2010         | Poisonous snake bites | 1900–2007  | Geier (2010)   |
| 61. | Berlin         | 2010         | Myasthenia gravis  | 1900–2008        | Koch (2010)   |
| 62. | Berlin         | 2010         | Asbestos           | 1900–2008        | Kröger (2010) |
| 63. | Berlin         | 2010         | Clostridium botulinum | 1905–2008  | Uibel (2010)   |
| 64. | Berlin         | 2010         | Age-related macular degeneration | 1900–2008 | Steinberg (2010) |
| 65. | Berlin         | 2010         | SARS               | 2003–2007        | Kreiter (2010) |
| 66. | Berlin         | 2010         | Epithelial precursor lesions | 1900–2008 | Grajewski (2010) |
| 67. | Berlin         | 2010         | Multiple sclerosis | 1900–2008        | Hoffmann (2010) |
| 68. | Berlin         | 2010         | Herpes simplex virus | 1900–2007        | Szerwinski (2010) |
| 69. | Berlin         | 2009         | Burnout syndrome  | 1983–2006        | Fröhlich (2009) |
| 70. | Berlin         | 2009         | Drowning accidents | 1900–2006        | Schilling (2010) |
| 71. | Berlin         | 2009         | Measles            | 1900–2008        | Rospino (2009) |
| 72. | Berlin         | 2009         | Human immunodeficiency virus (HIV) | 1982–2007 | Neye (2009) |
| 73. | Berlin         | 2009         | Carpal tunnel syndrome | 1900–2006 | Friedebold (2009) |
| 74. | Berlin         | 2009         | Streptococcus      | 1957–2006        | Bock (2009)   |
| 75. | Berlin         | 2009         | Syphilis           | 1900–2007        | Bircks (2010) |
| 76. | Berlin         | 2009         | Arthrosis          | 1900–2007        | Mayer (2009)  |
| 77. | Berlin         | 2009         | Telemedicine       | 1976–2006        | Rahimian (2009) |
| 78. | Berlin         | 2009         | Epilepsy           | 1900–2007        | Bircks (2010) |
| 79. | Berlin         | 2009         | Bronchial asthma   | 1967–2006        | Puk (2009)    |
| No. | Authors               | Year | Title                                                                 | Analysis interval       | Total number of published items | Reference                                      |
|-----|-----------------------|------|------------------------------------------------------------------------|-------------------------|---------------------------------|------------------------------------------------|
| 1.  | Börger et al.         | 2008 | Models of asthma: density-equalizing mapping and output benchmarking  | 1900–2006               | 3489                            | Borger et al. (2008)                      |
| 2.  | Groneberg-Kloft et al.| 2008 | Institutional operating figures in basic and applied sciences: scientometric analysis of quantitative output benchmarking | 1966–1976 1996–2006     | 5,527,558                       | Groneberg-Kloft et al. (2008b)             |
| 3.  | Groneberg-Kloft et al.| 2009 | Cough as a symptom and a disease entity: scientometric analysis and density-equalizing calculations | 1900–2007               | 12,960                          | Groneberg-Kloft et al. (2009a)            |
| 4.  | Groneberg-Kloft et al.| 2009 | Inter-disease comparison of research quantity and quality: bronchial asthma and chronic obstructive pulmonary disease | 1987–2006               | n.a.                            | Groneberg-Kloft et al. (2009d)            |
| 5.  | Kusma et al.          | 2009 | Tobacco control: visualisation of research activity using density-equalizing mapping and scientometric benchmarking procedures | 1952–2008               | 1846                            | Kusma et al. (2009)                       |
| 6.  | Schöffel et al.       | 2009 | The role of endocarditis, myocarditis and pericarditis in qualitative and quantitative data analysis | 1900–2007               | 18,967 (endocarditis) 7803 (myocarditis) 5552 (pericarditis) | Schöffel et al. (2009)                    |
| 7.  | Vitzthum et al.       | 2009 | Scoliosis: density-equalizing mapping and scientometric analysis       | 1904–2007               | 8186                            | Vitzthum et al. (2009)                    |
| 8.  | Al-Mutawakel et al.   | 2010 | Scientometric analysis of the world-wide research efforts concerning Leishmaniasis | 1957–2006               | 19,277                          | Al-Mutawakel et al. (2010)                |
| 9.  | Bohlen et al.         | 2010 | Scientometric analysis of the BMI                                     | 1900–2008               | 63,845                          | Bohlen et al. (2010)                      |
| 10. | Glynn et al.          | 2010 | Breast cancer research output, 1945–2008: a bibliometric and density-equalizing analysis | 1945–2008               | 180,126                         | Glynn et al. (2010)                       |
| 11. | Grajewski et al.      | 2010 | A scientometric analysis of leukoplakia and erythroplakia              | 1900–2008               | 2659                            | Grajewski et al. (2010)                   |
| 12. | Schöffel et al.       | 2010 | Reumatoid arthritis: scientific development from a critical point of view | 1901–2007               | 78,128                          | Schöffel et al. (2010a)                   |
| 13. | Scutaru et al.        | 2010 | Density-equalizing mapping and scientometric benchmarking of European allergy research | 2001–2007               | n.a.                            | Scutaru et al. (2010a)                    |
| No. | Authors          | Year | Title                                                                 | Analysis interval | Total number of published items | Reference                     |
|-----|------------------|------|----------------------------------------------------------------------|-------------------|---------------------------------|--------------------------------|
| 14  | Schöffel et al.  | 2010 | Arthroplasty: critical scientometric analysis of current benchmarking and evaluation procedures | 1901–2007         | 21,874                          | Schoffel et al. (2010b)        |
| 15  | Scutaru et al.   | 2010 | Density-equalizing mapping and scientometric benchmarking in Industrial Health | 1900–2014         | n.a.                            | Scutaru et al. (2010b)         |
| 16  | Schöffel et al.  | 2010 | Critical analysis of publication procedures and evaluation regarding ankylosing spondylitis by density-equalizing mapping and scientometric methods | 01–2007           | 8156                            | Schoffel et al. (2010c)        |
| 17  | Vitzthum et al.  | 2010 | Scientometric analysis and combined density-equalizing mapping of environmental tobacco smoke (ETS) research | 1900–2008         | 6580                            | Vitzthum et al. (2010a)        |
| 18  | Zell et al.      | 2010 | Air pollution research: visualization of research activity using density-equalizing mapping and scientometric benchmarking procedures | 1955–2006         | 26,253                          | Zell et al. (2010)             |
| 19  | Vitzthum et al.  | 2010 | Cardiac insufficiency: a critical analysis of the current publication procedures under quantitative and qualitative aspects | 1900–2007         | 82,828                          | Vitzthum et al. (2010)         |
| 20  | Mache et al.     | 2010 | Alzheimer’s Disease—a Scientometric Analysis and Data Acquisition     | 1985–2008         | 50,030                          | Mache et al. (2010)            |
| 21  | Groneberg et al. | 2011 | Drowning—a scientometric analysis and data acquisition of a constant global problem employing density equalizing mapping and scientometric benchmarking procedures | 1900–2006         | 2381                            | Groneberg et al. (2011)        |
| 22  | Healy et al.     | 2011 | The h index and the identification of global benchmarks for breast cancer research output | 1945–2008         | n.a.                            | Healy et al. (2011)            |
| 23  | Van Mark et al.  | 2011 | Shift- and Nightwork—a scientometric analysis                          | 1900–2008         | 3092                            | van Mark et al. (2011)         |
| 24  | Vogelzang et al. | 2011 | Depression and suicide publication analysis, using density equalizing mapping and output benchmarking | 1900–2007         | 6069                            | Vogelzang et al. (2011)        |
| No. | Authors          | Year | Title                                                                                                                                  | Analysis interval | Total number of published items | Reference                           |
|-----|------------------|------|----------------------------------------------------------------------------------------------------------------------------------------|-------------------|--------------------------------|-------------------------------------|
| 25  | Glynn et al.     | 2012 | Laryngeal cancer: quantitative and qualitative assessment of research output, 1945–2010                                                | 1945–2010         | 8658                           | Glynn et al. (2012)                 |
| 26  | Vogelzang et al. | 2012 | A bibliometric analysis of bipolar affective disorders using density-equalizing mapping and output benchmarking                           | 1900–2008         | 18,831                        | Vogelzang et al. (2012)             |
| 27  | Bundschuh et al. | 2013 | Yellow fever disease: density equalizing mapping and gender analysis of international research output                                    | 1900–2012         | 5053                           | Bundschuh et al. (2013)             |
| 28  | Fricke et al.    | 2013 | Influenza: a scientometric and density-equalizing analysis                                                                             | 1900–2009         | 51,418                        | Fricke et al. (2013)                |
| 29  | Gerber et al.    | 2013 | Gout: a critical analysis of scientific development                                                                                     | 1990–2012         | 4424                           | Gerber et al. (2013)                |
| 30  | Groneberg-Kloft et al. | 2013 | Traffic medicine-related research: a scientometric analysis                                                                             | 1900–2008         | 5193                           | Groneberg-Kloft et al. (2013)       |
| 31  | Schmidt et al.   | 2014 | Hepatitis B: global scientific development from a critical point of view                                                                  | 1971–2011         | 49,166                        | Schmidt et al. (2014)               |
| 32  | Addicks et al.   | 2014 | MRSA: a density-equalizing mapping analysis of the global research architecture                                                          | 1961–2007         | 7671                           | Addicks et al. (2014)               |
| 33  | Carl et al.      | 2014 | Curare—a curative poison: a scientometric analysis                                                                                     | 1900–2013         | 3867                           | Carl et al. (2014)                  |
| 34  | Gerber et al.    | 2014 | Antineutrophil cytoplasmic antibody-associated vasculitides: a scientometric approach visualizing worldwide research activity            | 1993–2013         | 6216                           | Gerber et al. (2014a)               |
| 35  | Mund et al.      | 2014 | Global research on smoking and pregnancy—a scientometric and gender analysis                                                            | 1900-2012         | 10,043                        | Mund et al. (2014)                  |
| 36  | Gerber et al.    | 2014 | A scientometric analysis of global research activity during the last 35 years                                                             | 1972–2012         | 11,839                        | Gerber et al. (2014b)              |
| 37  | Gerber et al.    | 2014 | Silicosis: geographic changes in research: an analysis employing density-equalizing mapping                                             | 1920–2012         | 2805                           | Gerber et al. (2014c)               |
| 38  | Pleger et al.    | 2014 | Bacterial meningitis: a density-equalizing mapping analysis of the global research architecture                                           | 1900–2007         | 7998                           | Pleger et al. (2014)                |
| No. | Authors            | Year | Title                                                                 | Analysis interval | Total number of published items | Reference                        |
|-----|--------------------|------|------------------------------------------------------------------------|-------------------|---------------------------------|-----------------------------------|
| 39  | Brüggmann et al.   | 2015 | Congenital toxoplasmosis: an in-depth density-equalizing mapping analysis to explore its global research architecture | 1900–2012         | 13,044                          | Bruggmann et al. (2015a)          |
| 40  | Geaney et al.      | 2015 | Type 2 Diabetes Research Yield, 1951-2012: Bibliometrics Analysis and Density-Equalizing Mapping | 1951–2012         | 24,783                          | Geaney et al. (2015)              |
| 41  | Brüggmann et al.   | 2015 | Caesarean Section-A Density-Equalizing Mapping Study to Depict Its Global Research Architecture | 1900–2013         | 12,608                          | Bruggmann et al. (2015b)          |
| 42  | Groneberg et al.   | 2015 | Density equalizing mapping of obesity: analysis of a global epidemic    | 1900–2009         | 94,987                          | Groneberg et al. (2015a)          |
| 43  | Ohlendorf et al.   | 2015 | Arthrosis: a scientometric analysis                                     | 1900–2013         | 46,212                          | Ohlendorf et al. (2015a)          |
| 44  | Groneberg et al.   | 2015 | Telemedicine—a scientometric and density equalizing analysis            | 1900–2006         | 3290                            | Groneberg et al. (2015b)          |
| 45  | Quarcoo et al.     | 2015 | Ebola and Its Global Research Architecture—Need for an Improvement     | 1976–2014         | 3081                            | Quarcoo et al. (2015)             |
| 46  | Groneberg et al.   | 2015 | Density equalizing mapping of the global tuberculosis research architecture | 1900–2012         | 58,319                          | Groneberg et al. (2015c)          |
| 47  | Ohlendorf et al.   | 2015 | Magnetic resonance imaging Density equalizing mapping analysis of global research architecture | 1981–2007         | 49,122                          | Ohlendorf et al. (2015b)          |
| 48  | Brüggmann et al.   | 2016 | Endometriosis and its global research architecture: an in-depth density-equalizing mapping analysis | 1900–2009         | 11,056                          | Bruggmann et al. (2016a)          |
| 49  | Groneberg et al.   | 2016 | Pancreatitis: Global Research Activities and Gender Imbalances: A Scientometric Approach Using Density-Equalizing Mapping | 1900–2012         | 27,826                          | Groneberg et al. (2016a)          |
| 50  | Brüggmann et al.   | 2016 | World-wide architecture of osteoporosis research: density-equalizing mapping studies and gender analysis | 1900–2012         | 57,453                          | Bruggmann et al. (2016b)          |
| 51  | Köster et al.      | 2016 | Rotavirus—Global research density equalizing mapping and gender analysis | 1900–2013         | 5906                            | Köster et al. (2016)              |
| No. | Authors            | Year | Title                                                                 | Analysis interval | Total number of published items | Reference                        |
|-----|--------------------|------|----------------------------------------------------------------------|-------------------|---------------------------------|----------------------------------|
| 52. | Brüggmann et al.   | 2016 | Global architecture of gestational diabetes research: density-equalizing mapping studies and gender analysis | 1900–2012         | 12,504                          | Bruggmann et al. (2016c)          |
| 53. | Groneberg et al.   | 2016 | Snakebite Envenoming—A Combined Density Equalizing Mapping and Scientometric Analysis of the Publication History | 1900–2016         | 17,998                          | Groneberg et al. (2016c)          |
| 54. | Schöffel et al.    | 2016 | Ulcerative colitis: A scientometric approach to the global research output and network | 1900–2016         | 40,343                          | Schoffel et al. (2016a)           |
| 55. | Schreiber et al.   | 2016 | Patient safety: the landscape of the global research output and gender distribution | 1963–2014         | 4079                            | Schreiber et al. (2016)           |
| 56. | Schöffel et al.    | 2016 | A critical perspective on the global research activity in the field of bladder cancer | 1900–2007         | 19,651                          | Schoffel et al. (2016b)           |
| 57. | Groneberg et al.   | 2016 | Analysis of the research architecture on the burnout syndrome         | 1983–2006         | 3146                            | Groneberg et al. (2016b)          |
| 58. | Schöffel et al.    | 2016 | Sarcoidosis: A Descriptive Approach to the Global Research Network and Recent Scientific Developments | 1900–2008         | 14,190                          | Schoffel et al. (2016c)           |
| 59. | Groneberg-Kloft et al. | 2016 | Analysis of research architecture in the field of psychiatric rehabilitation | 1900–2009         | 9271                            | Groneberg-Kloft et al. (2016)     |
| 60. | Schöffel et al.    | 2016 | Pancreatic Cancer-Critical Examination of the Global Research Architecture and Recent Scientific Developments | 1900–2013         | 11,445                          | Schoffel et al. (2016d)           |
| 61. | Brüggmann et al.   | 2017 | Polycystic ovary syndrome: analysis of the global research architecture using density equalizing mapping | 1900–2014         | 6261                            | Bruggmann et al. (2017a)          |
| 62. | Groneberg et al.   | 2017 | Glioblastoma research: US and international networking achievements    | 1900–2008         | 14,411                          | Groneberg et al. (2017)           |
| No. | Authors                  | Year | Title                                                                 | Analysis interval | Total number of published items | Reference                          |
|-----|--------------------------|------|-----------------------------------------------------------------------|-------------------|---------------------------------|------------------------------------|
| 63  | Brüggmann et al.         | 2017 | Ectopic pregnancy: exploration of its global research architecture using density-equalizing mapping and socioeconomic benchmarks | 1900–2012         | 8040                            | Bruggmann et al. (2017b)           |
| 64  | Götting et al.           | 2017 | Pulmonary Hypertension: Scientometric Analysis and Density-Equalizing Mapping | 1900–2007         | 18,986                          | Gotting et al. (2017)              |
| 65  | Brüggmann et al.         | 2017 | Respiratory syncytial virus: a systematic scientometric analysis of the global publication output and the gender distribution of publishing authors | 1900–2013         | 4600                            | Bruggmann et al. (2017c)           |
| 66  | Schöffel et al.          | 2017 | Hirschsprung Disease: Critical Evaluation of the Global Research Architecture Employing Scientometrics and Density-Equalizing Mapping | 1900–2015         | 2978                            | Schoffel et al. (2017a)            |
| 67  | Brüggmann et al.         | 2017 | Ovarian cancer: density equalizing mapping of the global research architecture | 1900–2014         | 23,378                          | Bruggmann et al. (2017d)           |
| 68  | Schöffel et al.          | 2017 | Evaluation of the Global Research Architecture Regarding Diabetic Retinopathy | 1900–2008         | 15,624                          | Schoffel et al. (2017b)            |
| 69  | Brüggmann et al.         | 2017 | Maternal depression research: socioeconomic analysis and density-equalizing mapping of the global research architecture | 1900–2012         | 7330                            | Bruggmann et al. (2017e)           |
| 70  | Groneberg                | 2018 | Biomedical Research in Wroclaw: A Combined Density-Equalizing Mapping and Scientometric Analysis | 1972–2016         | 10,366                          | Groneberg (2018a)                  |
| 71  | Brüggmann et al.         | 2018 | World-wide research architecture of vitamin D research: density-equalizing mapping studies and socio-economic analysis | 1900–2014         | 25,992                          | Bruggmann et al. (2018a)           |
| 72  | Groneberg et al.         | 2018 | The story behind Oncotarget? A bibliometric analysis                  | 2010–2017         | 21,961                          | Groneberg et al. (2018)            |
| 73  | Brüggmann et al.         | 2018 | Human papilloma virus: global research architecture assessed by density-equalizing mapping | 1900–2009         | 29,330                          | Bruggmann et al. (2018b)           |
| No. | Authors               | Year | Title                                                                 | Analysis interval | Total number of published items | Reference                      |
|-----|-----------------------|------|-----------------------------------------------------------------------|-------------------|--------------------------------|--------------------------------|
| 74. | Klingelhöfer et al.   | 2018 | Fifteen years after September 11: Where is the medical research heading? A scientometric analysis | 2001–2016         | 4250                           | Klingelhofer et al. (2018a)    |
| 75. | Brüggmann et al.      | 2018 | The uterine fibroid/myoma tumour: analysis of the global research architecture using density-equalizing mapping | 1900–2015         | 6176                           | Bruggmann et al. (2018c)       |
| 76. | Groneberg             | 2018 | Social sciences research in the Central European city of Wroclaw: A density-equalizing mapping analysis | 1966–2017         | 1787                           | Groneberg (2018b)              |
| 77. | Lammer et al.         | 2018 | Development of the global schizophrenia research under epidemiological and socio-economic influences | 1900–2015         | 42,492                         | Lammer et al. (2018)           |
| 78. | Trost et al.          | 2018 | Immigration: analysis, trends and outlook on the global research activity | 1900–2016         | 6763                           | Trost et al. (2018)            |
| 79. | Klingelhöfer et al.   | 2018 | Aflatoxin—Publication analysis of a global health threat              | 1900–2006         | 5122                           | Klingelhofer et al. (2018b)    |
| 80. | Schöffel et al.       | 2018 | Crohn’s Disease: A Critical Approach to Publication Procedures and Citation Behavior of the Global Research Network | 1900–2013         | 45,259                         | Schöffel et al. (2018)         |
| 81. | Trost et al.          | 2018 | Immigration: analysis, trends and outlook on the global research activity | 1900–2016         | 6763                           | Trost et al. (2018)            |
| 82. | Groneberg             | 2019 | Academic chemistry and related fields in Wroclaw: Density-equalizing mapping studies over the past decades | 1972–2016         | 15,267                         | Groneberg (2019)               |
appear to measure different dimensions. While citation rates were weakly associated with completeness of reporting, none of these metrics was related to methodological rigor. They suggested that high publication usage and journal outlet is not a guarantee of quality and readers should critically appraise all papers regardless of presumed impact (Mackinnon et al. 2018). Therefore, qualitative aspects are better addressed by advanced meta-analysis approaches using i.e. Cochrane systematics (Stovold et al. 2014).

Further issues

Scientometrics as research area is a niche within science. Funding is difficult to acquire for scientometric projects. However, it is the long term aim of NewQIS to analyze about 200 different areas within the next decade and to repeat assessments in 5- to 10-year intervals of important areas in order to assess changes in global research activities. When counting the raw data analyzed in the first 100 projects, we approximately invested about 50,000 work hours. Without extramural funding, this was only achievable by the workforce of medical students who performed their MD projects within NewQIS. In contrast to peer reviewed scientific reports which have been published for different NewQIS studies, a German medical thesis usually encompasses a much longer manuscript with 80–100 pages. This has been achieved by the medical students by writing comprehensive introductions about the field of research they analyze within their thesis. Thereby, they demonstrate that they possess an extensive knowledge about their thesis project. This is a prerequisite to obtain an MD degree. Also, the thesis students have to write detailed descriptions of their methodological approach (the NewQIS techniques) in the methods sections of the thesis and they have to discuss limits of the methodology in the discussion sections of their thesis.

This leads to two potential pitfalls:

(1) In the case of the methods sections, the thesis students have to follow strictly the above described protocols of NewQIS. This technical overlap is important and a strength of the platform in order to facilitate the comparison of results between the different diseases studied. However, it can be anticipated, that the use of these stringent protocols in nearly 80 different thesis projects—all with different target areas, i.e. ranging from burnout syndrome (Fröhlich 2009) to bronchial asthma (Puk 2009)—brings the same problem as rewriting a passage on the methodology of other highly structured techniques such as RT-PCR (reverse transcriptase-polymerase chain reaction) which has now been published more than 250,000 times according to the PubMed. As with nearly identical descriptions of PCR and other molecular biology methods which can be found in peer reviewed scientific papers, an overlapping wording does not represent an act of plagiarism but rather exemplifies the impossibility to reword a similar methods section for more than 80 times without overlapping sentences. This does also apply for the part of the discussion in which the methodology and its limitations are discussed. Addressing these issues, the international Committee on Publication Ethics (COPE) points to a guideline of BioMed Central editors which outlines the following: “Use of similar or identical phrases in methods sections where there are limited ways to describe a common method, (…), is not uncommon. In such cases, an element of text recycling is likely to be unavoidable in further publications using the same method. Editors should use their discretion when deciding how much overlap of methods text is acceptable, considering factors such as whether authors have been transparent and
stated that the methods have already been described in detail elsewhere and provided a citation” (COPE) (https://publicationethics.org/text-recycling-guidelines). Therefore, to overcome this pitfall, peer-reviewed NewQIS studies cite previous studies because of the methodological similarities—which are a strength of the platform. Also, thesis students are urged to cite every other NewQIS thesis which used the platform and to declare that the used methodology is part of NewQIS and therefore similar (apart from i.e. the different search terms).

(2) The introductions of the respective thesis usually follow the guidelines of up-to-date reviews i.e. on the disease which is analyzed for the thesis. In this respect, numerous introductions from NewQIS related thesis projects were also published as CME (continuing medical education) articles or as narrative reviews. Unfortunately, a recent analysis showed that within one thesis project, almost all parts of the introduction were copied by the student from the Wikipedia—a case of severe plagiarism that led to the deprivation of the Dr. med. degree (MD Thesis) of the student (Sudik 2011). In order to prevent future cases of plagiarism, all medical thesis now need to be analyzed within a plagiarism check prior to the official submission of the thesis to the medical school.

**Future of NewQIS**

The NewQIS platform will be used as NewQIS 2.0 in a next decade of further scientometric studies. There will be the following issues:

*Project of 200* As stated earlier, NewQIS 2.0 is intended to encompass about 200 different search projects with all areas of medicine, life sciences and also other areas of science in the next 10 years. Also, projects carried out 10 years ago and reported worldwide research activities (in the Web of Science) until 2005, should now be repeated in order to investigate the development of scientific activities.

*New focuses* Originally conceived as a tool to investigate publication activities in single areas of medicine, i.e. in different infectious diseases, NewQIS has also proven to be a valuable tool for other purposes, i.e. to analyze journals (Scutaru et al. 2010b; Groneberg et al. 2018). Also, it could be used for the analysis of cities with regard to research activities of affiliations in these cities. A recent example was the so-called NewQIS-Wroclaw project that assessed scientific activities in the Central European Polish city in three different areas: biomedical research, chemical research and social sciences (Groneberg 2018a, b, 2019) and demonstrated a strong increase over the past decades.

*New parameters* As introduced in the past years, NewQIS studies may also focus upon socio-economic features. In this respect, various economic key figures were used. I.e. two quotients were calculated to assess the scientific output of a specific country for RSV research (Bruggmann et al. 2017c):

1. in relation to the number of inhabitants (Q1)
2. in relation to its economic power (as measured by the gross domestic product, GDP, Q2) (Bruggmann et al. 2017c). Data regarding the population and GDP of investigated countries was obtained from 2012 The quotients were calculated as follows:

   1. Articles/population index (Q1) = number of articles/population in million inhabitants
   2. Articles/GDP index (Q2) = number of articles/GDP in 1000 billion US-Dollars
Within the RSV research NewQIS study, also, all countries were classified into high-income, upper-middle-income, lower-middle-income and low-income groups according to World Bank definitions (Bruggmann et al. 2017c). Then, the total number of RSV articles was related to the gross domestic expenditure on Research and Development (R&D in % of GDP) as well as to the number of researchers (per million inhabitants) affiliated to the investigated countries.

Conclusion

For over 10 years, the NewQIS platform has been used as a tool for peer reviewed scientific studies and for medical thesis in order to study numerous fields of science. As NewQIS 2.0 the project now heads into the next decade with a variety of new aspects in focus such as detailed socio-economic analysis or gender aspects. Using density equalizing mapping projections thousands of new pictures of global research landscapes will be generated. With numerous novel aspects that have been introduced to NewQIS within the past years, the platform will be a helpful tool for different aspects of scientometrics in the future.

Acknowledgements

We thank Beatrix Kloft for her pioneering work concerning NewQIS. Without her input, this platform would not exist. We also thank all involved scientists, among them many MD students and also senior scientists, for investing thousands of hours of academic work for the purpose of NewQIS.

Authors’ contributions

DAG, DK, DB, CS, AF and DQ conceived the review, and participated in the process of drafting the manuscript. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interests

The authors declare that they have no competing interests.

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