Biomedical Informatics Publications: a Global Perspective

Part II: Journals

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Summary
Background: Biomedical Informatics (BMI) is a broad discipline, having evolved from both Medical Informatics (MI) and Bioinformatics (BI). An analysis of publications in the field should provide an indication about the geographic distribution of BMI research contributions and possible lessons for the future, both for research and professional practice.
Objectives: In part I of our analysis of biomedical informatics publications we presented results from BMI conferences. In this second part, we analyse BMI journals, which provide a broader perspective and comparison between data from conferences and journals that ought to confirm or suggest alternatives to the original distributional findings from the conferences.
Methods: We manually collected data about authors and their geographical origin from various MI journals: the International Journal of Medical Informatics (IJMI), the Journal of Biomedical Informatics (JBI), Methods of Information in Medicine (MIM) and The Journal of the American Medical Informatics Association (JAMIA). Focusing on first authors, we also compared these findings with data from the journal Bioinformatics.
Results: Our results confirm those obtained in our analysis of BMI conferences – that local and regional authors favor their corresponding MI journals just as they do their conferences. Consideration of other factors, such as the increasingly open source nature of data and software tools, is consistent with these findings
Conclusions: Our analysis suggests various indicators that could lead to further, deeper analyses, and could provide additional insights for future BMI research and professional activities.

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1. Introduction

While conferences are a most popular means of scientific communication, journals remain the preferred way of reporting research results in most scientific fields. However, in some subfields of computer science, conferences have, over the past decades, become as important as journals, being preferred to journals in some subfields of the discipline [1]. We therefore felt that an analysis of papers reported at BMI conferences, and a comparison to publications in BMI journals might provide some new insights. This made us expand our analysis reported in part I [2], so as to also include BMI journals.

To obtain a preliminary sense of the data, we initially recorded data for journals from 2010, then extending the analysis to publications from issues of 2008 and 2009. The journals for medical informatics (MI) that we analyzed were, in alphabetic order

- International Journal of Medical Informatics (IJMI)
- Journal of Biomedical Informatics (JBI)
- Methods of Information in Medicine (MIM)
- The Journal of the American Medical Informatics Association (JAMIA)

And for bioinformatics we chose the journal bearing the same name:

- Bioinformatics

2. Methods

As stated above, we initially collected data from various BMI journals for the year 2010. We manually gathered data – derived from searches using PubMed/Medline over the websites of all the journals – about the papers published in them. We classified these papers according to the geographical origin of the first author of each publication. In this case, we did not want to present an exhaustive comparison but only to uncover general trends that might be related to the results we had already obtained for the conferences and presented in the previous part I of this manuscript. Later we also recorded data from 2008 and 2009, to avoid potential biases resulting from circumstances that might have arisen in 2010. Related reports and references have been detailed in part I of this analysis [3–6].

As in our previous paper, we carried out an analysis of the reported geographical origin of the first authors of papers published in various BMI journals to check if the data were similar or not to that reported for the conferences Medinfo, MIE, AMIA, and ISMB. First, we analysed results from publications appearing in two journals that might be considered to be historically representative of the two BMI communities, geographical locations and their corresponding MI societies: JAMIA – for AMIA, in the USA – and MIM – for EFMI, in Europe.

The pie charts in ▶Figures 1 and 2 graphically represent data collected for JAMIA and MIM. For AMIA (see Part I), the proportion of first authors from the USA publishing in JAMIA is significantly higher than those from the EU, whereas for MIE, the opposite result is obtained for MIM. (Note: Tables with full data are included in the Appendix.)

Similarly to what was done in Part I, where we compared the three MI conferences (Medinfo, MIE, AMIA) with ISMB, we have also compared data from JAMIA and MIM with that taken from the Bioinformatics journal, which is both well-know and has a high impact factor. It is published in the United Kingdom, and is representative of the BI community as it is the official publication for International Society for Computational Biology (ISCB).

Finally, to provide a broader perspective, we carried out an additional analysis of two more BMI journals, more closely focused on MI. One is the Journal of Biomedical Informatics whose scope changed with the name change from the original Computers and Biomedical Research, encompassing now many new topics associated with the broader BMI perspective. The second one is the International Journal of Medical Informatics, which is also an official journal of EFMI. Data are shown in ▶Figures 4 and 5.

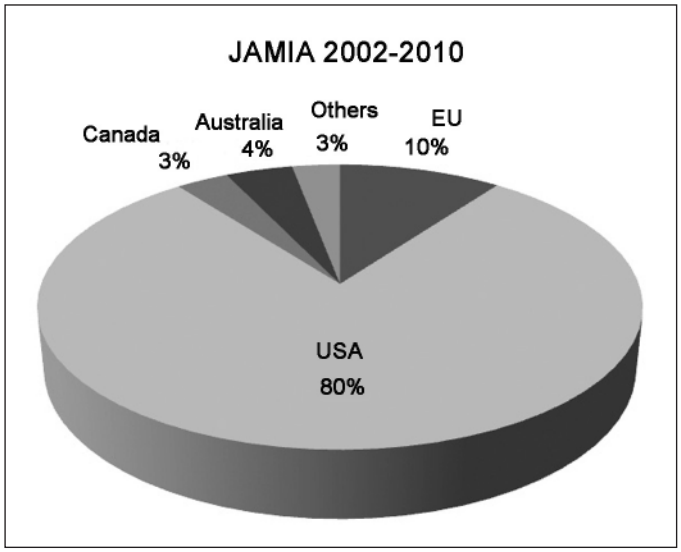

Fig. 1 Pie chart showing the distribution of first authors from JAMIA 2008–2010 issues, taken from Table 1 in the appendix

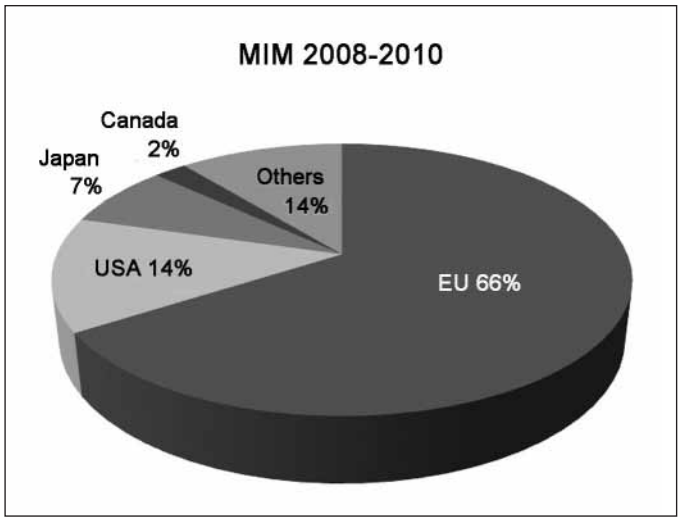

Fig. 2 Pie chart showing the distribution of first authors from MIM 2008–2010 issues, taken from Table 2 in the appendix

3. Discussion

▶Figure 6 gives an overall summary of the results, where the proportion of US publications by first author are compared against those from the EU, for all the conferences and journals included in this paper (parts I and II). For this analysis we have not considered the Journal of Medical Internet Research or BMC Medical Informatics and Decision Making. These two journals are more recent and included in the ISI database and they adopt an open access policy, so it may take some time yet to consolidate their data, requiring further analysis to specifically consider the impact of their open editorial strategies.

The simple statistical comparison of first author contributors shown in ▶Figure 6 illustrates very starkly the contrast between regional/national and international publishing venue preferences. The proportions for JAMIA are quite similar to those obtained for the period 2005–2009 for the AMIA symposium: 79.40% from USA and 10.15% from the EU in JAMIA 2008–2010 vs 82.88% from USA and 10.20% from the EU in AMIA 2005–2009, with some increased regional participation for special issues [7].

For the journal Methods of Information in Medicine (MIM), results diverge from the MIE conference, in comparison to the JAMIA-AMIA results, but they also present interesting similarities: 74.67% participation from the EU and 3.33% from USA at MIE and 65.94% from the EU and 13.54% from the USA in MIM.

However, for Bioinformatics – comparing ISMB and the Bioinformatics journal –, there are no such pair-wise associations as with the MI conferences and traditional MI

journals with respect to similarities in geographical breakdown of first authors' geographical origins. Whereas in ISMB there is a predominance of USA participants (47.81%) vs. those coming from the EU (25.55%), in Bioinformatics there are no significant differences between both authors' places of origin for the two predominant contributor regions considered (36.66% for USA and 37.95% for EU).

In the cases of IJMI (41.29% for EU and 30.65 for USA) and JBI (22.93% for EU and 49.60% for USA), results are quite different, but no practical significant conclusions can be drawn from the small sample and direct geographical comparison that we analyzed. We can only observe a larger percentage for US authors in JBI and European authors in IJMI, but the contrast is not as significant as that for results we obtained from JAMIA and MIE, respectively. We can observe, however, that since JBI is now focused on those aspects of BMI more related to translational science, it now includes a larger proportion of papers from-BI.This journal is more closely tied to the USA, with an editorial board with many members from the USA, and a large number of US authors (in the period 2008–2010). In contrast, IJMI is linked to EFMI, although its scientific committee includes a large number of US researchers – like MIM – and results for US and EU researchers were closer (in the period 2008–2010), and it is more focused on applied research, including comprehensive healthcare systems' evaluations. Both journals differ from MIM and JAMIA in patterns of first authorship, which suggests the need for a more detailed analysis that would take into account other factors and variables.

Our analysis emphasizes the point that, after at least one decade as a broadly defined discipline, BMI, encompassing professionals and researchers from both MI and BI, from a global perspective, still exhibits significant differences in terms of geographical contributions by origin of the first authors of scientific publications in the field. These results indicate that, in traditional MI venues or environments, there is a predominance of US authors in representative US conferences and publications, larger, in general, than EU authors in Euro-

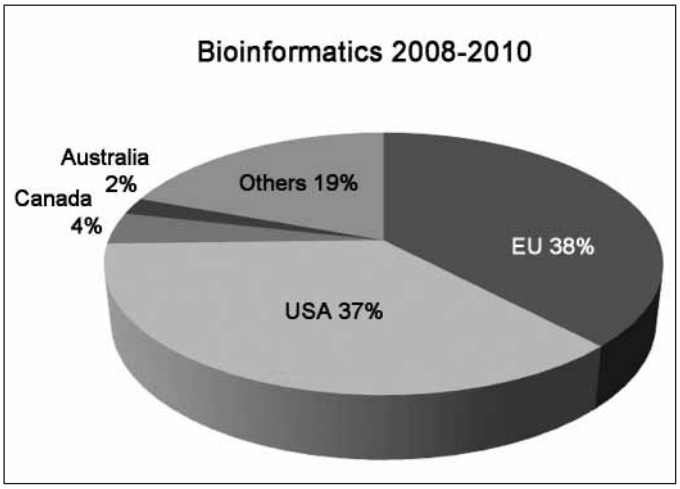

Fig. 3 Pie chart showing the distribution of first authors from Bioinformatics 2008–2010 issues, taken from Table 3 in the appendix

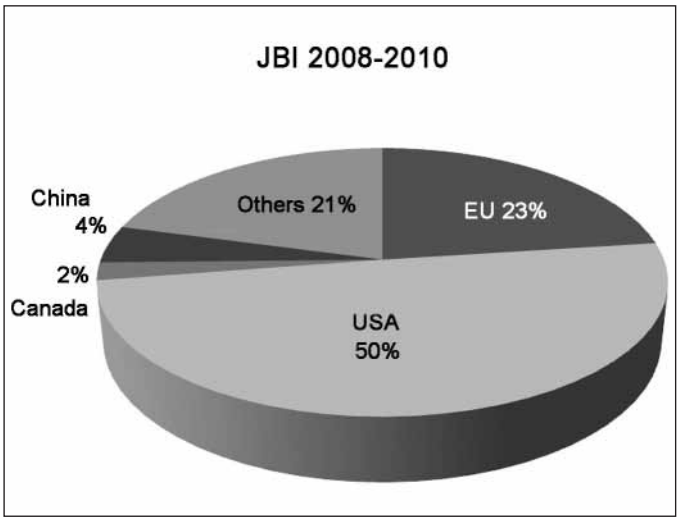

Fig. 4 Pie chart of the distribution of first authors from JBI 2008–2010 issues, taken from Table 4 in the appendix

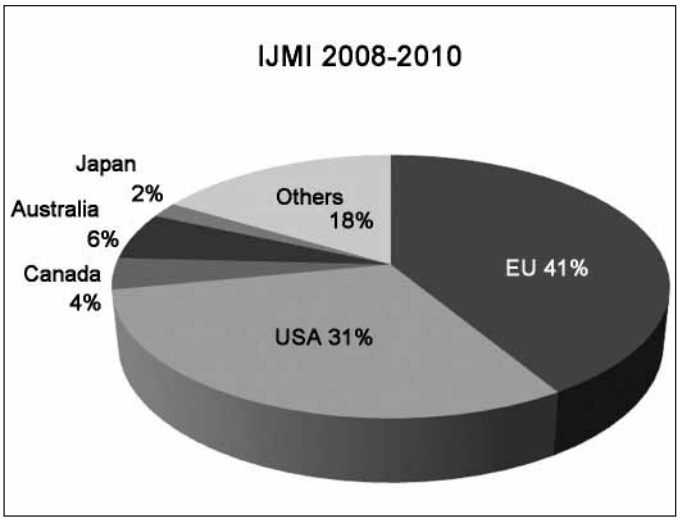

Fig. 5 Pie chart of the distribution of first authors from IJMI 2008–2010 issues, taken from Table 5 in the appendix

pean conferences and journals. However, such large differences do not appear in the ISMB conference or the Bioinformatics journal – and results also differ in JBI and IJMI.

Within the current globalized economy and the social Web 2.0, which links networks of people in every way of life around the world, collaborations and exchanges are being reinforced. A motivation behind the integrated term "Biomedical Informatics" has been to establish strong links between MI and BI. Or, both disciplines are often considered to have merged. This prompts us to ask what might be the effect on the scientific impact of publications if all topics and issues shared by both disciplines were actually integrated under the BMI umbrella? The ISI ranking of journals would likely change. Let us consider what might happen if we extract, from the different ISI fields – "Medical Informatics", "Mathematical and Computational Biology" and other related terms – the different MI and BI journals that are now available for researchers and we create a new subject area called "Biomedical Informatics", which gathers BMI journals currently included in these separated lists.

BMI has a large list of journals with scientific impact. Thomson-Reuters' ISI database© (a for-profit company) – with its Journal of Citation Reports (JCR) and associated impact factor for each publication [8], is based on the number of citations in relevant journals – and is a commonly-accepted measure for evaluating and ranking journals [9]. Within the ISI database, "Medical Informatics" is an accepted subject area, with 22 journals ranked in the latest available JCR version available at the time of writing (2010). In contrast, there is no subject area under the name of "Bioinformatics", although there is one for "Mathematical and Computational Biology" with 37 journals – which does not include some BI journals such as Briefings in Bioinformatics. The impact factors of BI journals are relatively higher than those for MI.

If we combine the different current rankings of MI and BI journals at the time of writing, such a combined ranking would lead to a new overall ranking. In this, for instance, the Journal of Medical Internet Research (JMIR) and JAMIA – which at present lead the ranking of the "Medical Informatics" field – they might go from their current 1st and 2nd positions to, respectively, 4th and 6th – as shown in such a new, expanded hypothetical ranking for the combined BMI field, presented in ▶Table 1, which takes the most highly ranked journals belonging to both MI and BI. The Journal of Medical Internet Research and JAMIA follow, in this combined MI-BI ranking, with other BI journals – Briefings in Bioinformatics, PLOS Computational Biology and Bioinformatics before JMIR and also BMC Systems Biology appearing before JAMIA – because they currently have a larger impact factor. Other traditional MI journals would also be lowered from their current positions. ▶Table 1 shows the upper part of such a hypothetical new combined ranking that might integrate classical MI and BI journals.

Such a new ranking might also lead to changes in the current patterns of submissions to BMI journals and also to the patterns of citations of BMI researchers,

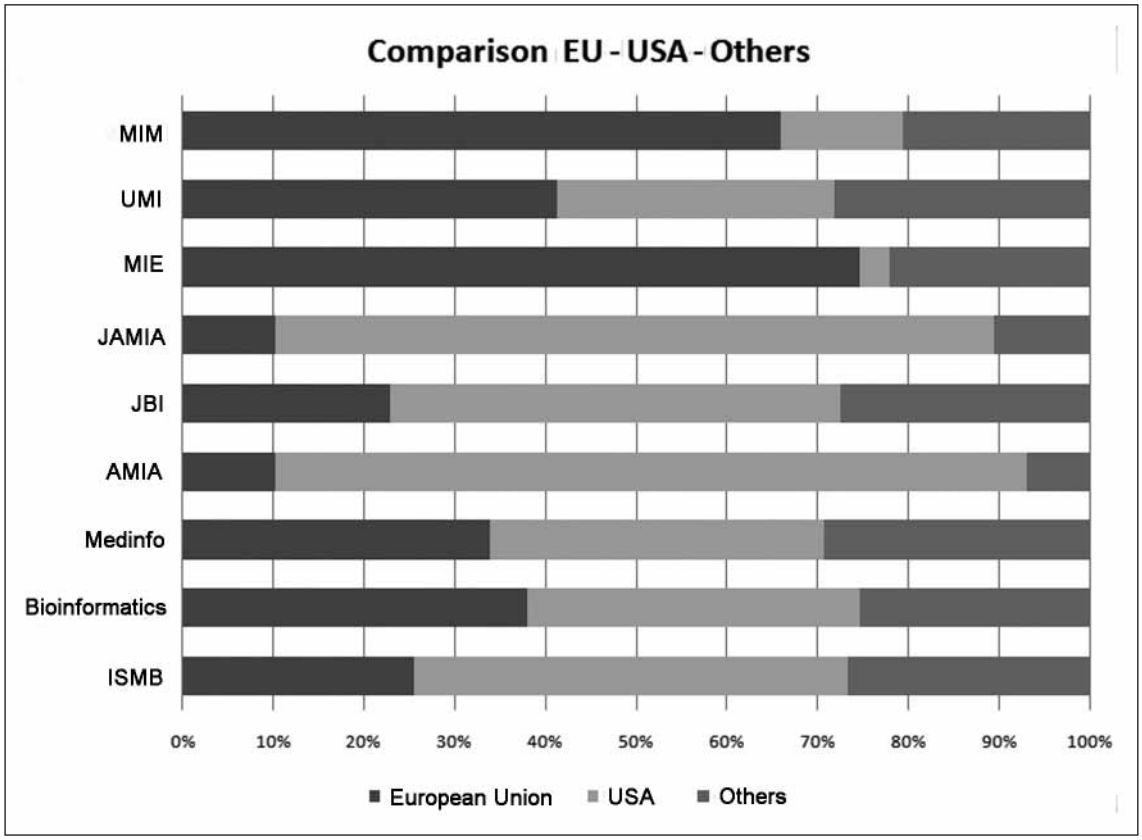

Fig. 6 Summary of results with proportions of USA vs EU vs other participants (by first author) in the conferences (MIE, AMIA, Medinfo, ISMB, from part I of this manuscript) and authors of publications in journals (*MIM*, IJMI, JAMIA, JBI and Bioinformatics). Data taken from Table 6 in the appendix

journals and papers. Thus, such a reorganization could also lead to further changes in impact factors. In any case, we can easily observe – just by browsing PubMed/Medline – that, currently, most traditional MI journals – and conferences – do actually include a large number of traditional BI topics and papers in their contents, but that the opposite – classical MI papers appearing in BI journals – is very infrequent. This finding may have implications for how publications are likely to develop and differentiate for the very recently emerging translational informatics field, though it is too early to analyze or comment on this. Considering the above combined publication rankings, then, the vision of an integrated BMI discipline may prove to be still very much a "work in progress". The 2007 longitudinal social network analysis of editorial board composition mentioned above [3] seems to support – at least, partially – such a remark.

However, more complex explanations may be needed for the above findings. Possibly the structure and breadth of the MI field, divided into regional societies with many different emphases of their disciplinary subgroups –, hinders on-going exchange and joint participation of researchers from all continents in the most significant conferences and journals in the field. This is different to what actually happens in other areas – including the closely-related one of BI – and a possible reason for this is the separation between the sub-communities, where additional exchanges and synergies might be expected. We have also obtained data about the geographical origins of the scientific committees and editorial boards of these MI journals and conferences, which seem to support – with the only significant exceptions of MIM and IJMI (which have a large participation by US scholars) – the kinds of results that we have found, showing a decidedly regional focus for so many publication venues. In this regard, as mentioned in part I of this manuscript [2], an earlier report thoroughly discusses the issue of editorial boards of journals [3], which involves many other factors and will not be further addressed here. However, we can note that it is probably the case that communities of researchers, practitioners and academics have all fragmented so much in our web-based age of specialization as to make general conferences and journals much less attractive for reporting original findings, which are typically announced in specialty conferences that are more likely to produce feedback from other experts in the speciality.

Table 1
The top section of a hypothetical expanded BMI-centered ISI ranking, including MI and BI journals, showing the first seven results – with data borrowed from the 2010 ISI's Journal of Citation Reports (JCR) ranking

Journal	Impact factor in 2010 (after merging MI and BI)
1. Briefings in Bioinformatics	9.28
2. Plos Computational Biology	5.51
3. Bioinformatics	4.87
4. Journal of Medical Internet Research	4.66
5. BMC Systems Biology	3.96
6. JAMIA	3.07
7. BMC Bioinformatics	3.02

Another possible issue for discussion concerns differences in open source data and in research outcomes. Open source development environments and strategies of information exchange have proven quite successful for the BI community, as already stated above. In contrast, the MI community has had to take into account more industry-related strategies since privacy, security, confidentiality and reliability of data are more critical to computer-based patient management and decision support and the roles of intermediaries (i.e. insurance and pharmaceutical companies, and government entities), between practitioners and patients in "ownership" and dissemination and use of patient data. For instance, the open source strategy – which is required by various top-ranked BI journals for both data and software – has generated much debate in the MI community – as shown by many exchanges of messages in AMIA Working Groups' mailing lists – and reaching consensus does not appear on the horizon because of the ethical, social, legal, and business complexities as noted above. However, we can also consider that by requiring open resources (data, databases, software programs and libraries, services, etc.), some BI journals may be also enhancing their visibility, impact and recognition within and outside the BMI community beyond what is achieved by MI journals and researchers! This suggests that adopting more openness as a strategy in MI – and especially by MI journals – might contribute to increasing the visibility and recognition of research outcomes inside and outside BMI if some of the barriers mentioned above can be overcome.

Encouraging more openness in MI for the non-privacy-sensitive methods and software might prove significant in helping biomedical professionals from poor regions and countries to afford health information systems, by using open informatics resources [10]. This is a direction where the authors have been active in Africa, working on various initiatives to teach African professionals BMI methods and tools can transfer open BMI results to these areas – but this introduces yet another topic which would require further discussion in a separate forum. We would like to mention that we have carried out extensive research in text mining methods to automatically extract information about informatics resources (software, databases, tools, services) from the scientific literature [11–16]. We originally carried out this work in BI, later expanding it to include MI. However, such text mining work proved more difficult in the MI field, given the low number of open informatics resources in the area and the poorly structured abstracts in MI, in contrast to those in BI.

Finally, during our analysis of papers in the MI area we were surprised at the low number of letters to the editor they usually contain, in contrast to those routinely published in other journals in biomedicine and science. Usually, such letters in BMI journals do not seek to open a debate about deep scientific issues nor to challenge previously

published results and statements. This is not necessarily a positive reflection on the strength of a discipline. Most top-ranked journals (notably Nature, Science or The New England Journal of Medicine) have a regular section where they publish letters to the editor, refutations and retractions that actually lead authors to be more careful about their publications and strengthen the scientific content of the journals. The lack of debate in MI journals may reflect the professional courtesy traditions of medical practice, but can lead to the build-up of unresolved issues which can eventually erupt with great force when contradictions are pointed out in apparent consensus views [17, 18]. It can be argued that BMI needs to move towards the kind of active open scientific debates such as those carried out many years ago in other disciplines (i.e. the 1927 Solvay conference [19], where Einstein posed difficult thought experiments during the debates that challenged the very foundations of quantum mechanics, but which where satisfactorily answered by Bohr and his colleagues – after exhaustive analyses overnight! Such a debate contributed to consolidate the discipline of physics and also helped forge a lifelong friendship between both men).This may be unrealistic considering the ambitious breadth of BMI in spanning biomedical research, clinical practice and worldwide public health informatics where science, technology, and clinical practice all have very different goals and methodologies. However, the field is exceptionally well placed to attempt asking the tough questions and stimulate the deep probing about the experimental scientific basis of BMI to help identify its "foundational grand challenges" beyond stating the very superficial and obvious complexities entailed by the diversity of objectives and heterogeneity of its types of information.

4. Conclusions

From June 9 to 11, 2011, a symposium celebrating the 50th anniversary of Methods of Information in Medicine (MIM) [20] was held in Heidelberg, Germany. A broad spectrum of BMI researchers attended, in addition to members of the MIM board. During this event, McCray presented in her introductory speech a deep and illuminating analysis of the MIM papers published over the past five decades [21]. This analysis included such factors as number of papers published, citations (both inside and outside the discipline), most relevant keywords (and how these evolved over five decades), changes in trends, most cited papers, areas of research, impact factors and other interesting data. The participation and geographical origins of authors was also suggested as a possible topic. Taking this in mind, a more comprehensive analysis, extending our analyses in the directions proposed by McCray to include a broader range of conferences and journals might well provide very interesting information about the past decades in biomedical information, as well as lessons for the future. Such a comprehensive work would need support from the journals and conference editors' – providing access to direct data, avoiding the tedious and error-prone work that we have experienced ourselves – and also from organizations like BMI societies, agencies, the European Commission, and the US National Library of Medicine.

The data presented in both manuscripts – parts I and II – suggest challenges that lie ahead if we are to reinforce collaborative and scientifically-focused activities and opportunities for BMI professionals, at an international level, beyond conventional praise for its desirability. At this time, the data summarized here seem to suggest, that such an integrative vision of BMI needs reinforcement, particularly when we consider the geographical differences in the distribution of participants at important BMI conferences, and the differences of goals and methodologies among the very diverse membership of BMI communities of practice. In the current global environment, the opportunities that can come from such collaborations might lead to new synergies and new research agendas for BMI and reinforce the role of worldwide international associations such as IMIA and ISCB for connecting BMI professionals with regional and national societies.

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Appendix

Table 1 Results of first author location for JAMIA (2008–2010)

	2008	2009	2010	Σ	Percentage
EU	12	14	8	34	10.15%
USA	83	89	94	266	79.40%
Canada	4	4	3	11	3.28%
Australia	3	5	6	14	4.18%
Others	4	2	4	10	2.99%
Total	**106**	**114**	**115**	**335**	**100 %**

Table 2 Results of first author location for MIM (2008–2010)

	2008	2009	2010	Σ	Percentage
EU	39	58	54	151	65.94%
USA	15	7	9	31	13.54%
Japan	8	6	3	17	7.42%
Canada	1	2	2	5	2.18%
Others	8	7	10	25	10.92%
Total	**71**	**80**	**78**	**229**	**100 %**

Table 3 Results of first author location for Bioinformatics (2008–2010)

	2008	2009	2010	Σ	Percentage
EU	255	264	246	765	37.95%
USA	243	248	248	739	36.66%
Canada	23	26	30	79	3.92%
Australia	11	8	23	42	2.08%
Others	113	126	152	391	19.39%
Total	**645**	**672**	**699**	**2016**	**100 %**

Table 4 Results of first author location for JBI (2008–2010)

	2008	2009	2010	Σ	Percentage
EU	24	27	35	86	22.93%
USA	43	54	89	186	49.60%
Canada	4	1	3	8	2.13%
China	6	4	7	17	4.53%
Others	23	20	35	78	20.80%
Total	**100**	**106**	**169**	**375**	**100 %**

Table 5 Results of first author location for IJMI (2008–2010)

	2008	2009	2010	Σ	Percentage
EU	35	47	46	128	41.29%
USA	25	35	35	95	30.65%
Canada	4	6	2	12	3.87%
Australia	6	8	4	18	5.81%
Japan	1	3	2	6	1.94%
Others	19	19	13	51	16.45%
Total	**90**	**118**	**102**	**310**	**100 %**

Table 6 Results combined from conferences and journals

	EU	USA	Others
ISMB	25.55	47.81	26.64
Bioinformatics	37.95	36.66	25.39
Medinfo	33.8	36.9	29.3
AMIA	10.2	82.9	6.9
JBI	22.93	49.6	27.47
JAMIA	10.15	79.4	10.45
MIE	74.7	3.3	22
IJMI	41.29	30.65	28.06
MIM	65.94	13.54	20.52