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The Three-Step Workflow: A Pragmatic Approach to Allocating Academic Hospitals' Affiliations for Bibliometric Purposes

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Abstract

Purpose: A key question when ranking universities is whether or not to allocate the publication output of affiliated hospitals to universities. This paper presents a method for classifying the varying degrees of interdependency between academic hospitals and universities in the context of the Leiden Ranking.

Design/methodology/approach: Hospital nomenclatures vary worldwide to denote some form of collaboration with a university, however they do not correspond to universally standard definitions. Thus, rather than seeking a normative definition of academic hospitals, we propose a three-step workflow that aligns the university-hospital relationship with one of three general models: full integration of the hospital and the medical faculty into a single organization; health science centres in which hospitals and medical faculty remain separate entities albeit within the same governance structure; and structures in which universities and hospitals are separate entities which collaborate with one another. This classification system provides a standard through which publications which mention affiliations with academic hospitals can be better allocated.

Findings: In the paper we illustrate how the three-step workflow effectively translates the three above-mentioned models into two types of instrumental relationships for the assignation of publications: “associate” and “component”. When a hospital and a medical faculty are fully integrated or when a hospital is part of a health science centre, the relationship is classified as component. When a hospital follows the model of collaboration and support, the relationship is classified as associate. The compilation of data following these standards allows for a more uniform comparison between worldwide educational and research systems.

Research limitations: The workflow is resource intensive, depends heavily on the information provided by universities and hospitals, and is more challenging for languages that use non-Latin characters. Further, the application of the workflow demands a careful evaluation of different types of input which can result in ambiguity and makes it difficult to automatize.



Practical implications: Determining the type of affiliation an academic hospital has with a university can have a substantial impact on the publication counts for universities. This workflow can also aid in analysing collaborations among the two types of organizations.

Originality/value: The three-step workflow is a unique way to establish the type of relationship an academic hospital has with a university accounting for national and regional differences on nomenclature.

Keywords Academic hospitals; Universities; Bibliometrics; Organizational affiliations; Rankings

1 Introduction

Determining a universal definition for what constitutes a university is a challenging task (Birtwistle, 2003; Rochford, 2006) which is complicated by internationalization (Altbach, 2004), rankings (Dill, 2006), strategic mergers (Labi, 2011), and the evolving roles and social expectations placed on universities (Denman, 2005). Likewise, characterizing the relationships between universities and their affiliated organizations can be problematic given the different degrees of interdependency that exist between them. This is particularly evident in the case of academic hospitals (Barrett, 2008).

Not only do these institutions tend to follow particular national systems, but they also evolve constantly in response to economic factors and sociopolitical expectations (Wartman, 2008). Building on Praal et al.'s (2013) research into the challenges of including affiliated institutes in a university's publication count, this paper describes the various academic hospital systems we have encountered and proposes a mode of classifying the university-hospital relationship in the context of the Leiden Ranking.

Hospital nomenclatures vary worldwide to denote some form of collaboration with a university: academic hospitals, teaching hospitals, university hospitals, and academic medical centres do not correspond to universally standard definitions. Rather than seeking a normative definition of "academic hospital", we are proposing a method of allocating publications that only mention affiliations with such hospitals. For the purpose of the Leiden Ranking, we distinguish between three general models of hospital-university relationships in order to measure the research output of universities through publications. This exercise is necessary because the organizational boundaries of universities are not always clear. In addition, the information provided under author affiliations may not always be accurate, for example when researchers mention their working address at the affiliated hospital but omit their university affiliation. In this respect, our methodology aligns with Hardeman's (2013) claim that university output cannot be objectively identified



because there is no universal and objective definition of what constitutes a university. This is exacerbated by the fact that affiliations serve two general purposes: providing contact information for the authors and attributing credit to the employer(s).

1.1 Organizations involved

A wide variety of definitions exist for what constitutes a university, a hospital, and in particular an academic hospital. Below we outline the concepts that will appear in this article.

As per the Leiden Ranking framework, we consider universities as higher education institutions that award degrees of the third cycle (Leiden Ranking, 2021) in accordance with the *Framework for Qualifications of the European Higher Education Area* (Bologna Working Group on Qualifications Frameworks, 2005).

In general terms, a hospital is perceived as an institution for healthcare provision. In most countries, a hospital will be considered as academic when it is connected to a higher education institution in some form. Although a precise definition and clear organizational structure for academic hospitals do not currently exist, the attribute of “academic” indicates such hospitals have a tripartite mission of patient care, education, and research. For the purposes of our classification system, we are most concerned with the hospital’s relationship to the university in the areas of education and research.

Before we move on, it is worth noting that academic medical centres can differ substantially in size and organizational complexity. In addition, these organizations are constantly changing. What was once a single academic hospital may now be an entire campus or an academic health science centre comprising several hospitals, clinics, laboratories, and even research centres; we do not differentiate between single academic hospitals and these larger structures. As aforementioned, what we seek is to employ the university-hospital relationship in the areas of education and research as an instrument to measure publication output. More specifically, we consider whether the publications mentioning only an affiliation with an academic hospital should be included or disregarded in the count of a university’s output.

1.2 Literature review on academic hospitals

The majority of the literature on academic hospitals either examines the organizational aspect of such institutions or focuses on their various outcomes (Zinner & Campbell, 2009). Below we provide a non-exhaustive overview of the most common research topics.

Many studies discuss the various organizational structures of academic centres (Barrett, 2008; Daniels & Carson, 2011; Davies, Tawfik-Shukor, & de Jonge, 2010), including their governance (Griner & Blumenthal, 1998; Gaynor, Laudicella, &



Propper, 2012), and the effects of ongoing restructuring and mergers. Researchers also often highlight the complexity of processes that arises from specific policies (French, Ferlie, & Fulop, 2014) and budget constraints (Fuchs, 2013).

Other scientific literature focuses on the different expectations placed on academic hospitals due to their tripartite mission (Lozon & Fox, 2002) as well as on the changing roles and challenges that academic medical education faces (Gallin & Smits, 1998; Nonnemaker & Griner, 2001; Wartman et al., 2009). Related to this are studies analyzing the conflicting interests between universities, public health organizations, and industry (Brennan et al., 2006; Cohen & Siegel, 2005; Rothman & Chimonas, 2010; Washington et al., 2013). This is especially the case when higher education institutions must find befitting partnerships to fulfil the demands for innovation (Fish, 2013).

Several articles treat specifically the subject of academic science centres and health networks (Fish, 2013; Nicholson et al., 2015; Ovseiko et al., 2014; Wijgert, 2010). Such articles reflect upon the expanding and conflicting expectations that public institutions face in the wake of budget constraints and cost-reduction mergers, and the accountability issues that arise from these events.

Aside from some articles on resource utilization in relation to teaching activities (Sato & Fushimi, 2012), the area of education, a fundamental part of the tripartite mission of academic hospitals, has received little scholarly attention. When it does receive attention, rarely a distinction is made between the different types of education such as patient, professional, postgraduate, or undergraduate education. This lack of distinction in the literature is an indication of the organizational complexity whereby the different types of education provided at hospitals follow the priorities of different governmental departments, most often those of education and health. Therefore, the term “teaching” is generally used in the literature in its broadest sense.

Although most articles focus on regional or national cases, many authors devote attention to developing a general definition of what constitutes an academic hospital. However, the diversity of educational, research, and public health models, coupled with the ever-changing relationships between universities and hospitals, make organizational definitions challenging even at the national level. As several scholars note, if you have seen one [academic medical hospital or medical school], you have seen only one (Lozon & Fox, 2002).

2 Methodology

This section describes the three types of affiliation that we distinguish between an academic hospital and university. It then outlines how to identify the type of relationship by applying the three-step workflow and how to interpret the findings.



2.1 Relationship models of academic hospitals

Hospitals affiliated with universities are relevant elements of academic systems where education and research take place (Washington et al., 2013). Nevertheless, there are significant differences in the types of relationships between hospitals and universities both on an international and national level: on one end of the spectrum there are fully integrated hospitals and medical faculties, while on the other end there are non-integrated hospitals offering clinical placements for students. In between lies an array of structures at varying degrees of interdependency, all determined by national and regional systems.

Examining the organizational structures of university-affiliated hospitals, Wartman describes two prototypical models of academic health centres, while Levine considers five possible structures with varying degrees of interdependency (Levine, 2002; Wartman, 2015). For the purpose of the Leiden Ranking, we identify three general models for relationships between universities and hospitals:

1. full integration of the hospital and the medical faculty into a single organization;
2. health science centres in which hospitals and medical faculty are still separate entities, albeit within the same governance structure;
3. structures in which universities and hospitals are separate entities and collaborate with one another.

The case of fully integrated academic hospitals shows a strong degree of interdependency with a particular university, for example, when the medical faculty is located at the hospital or vice versa (see Figure 1). This model is found in most academic hospitals of Belgium, the Netherlands, Germany, and Switzerland.

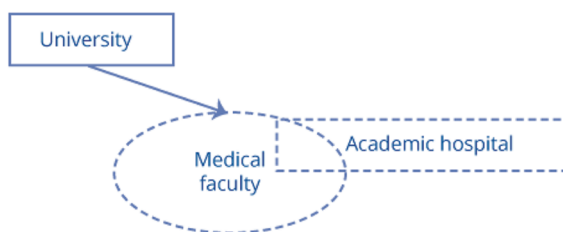


Figure 1. Full integration model.

The system of Health Science Centers also presents a strong degree of interdependency between academic hospitals and universities but the structure differs from the full integration model. In the full-integration model, the medical faculty and hospital are often the same institution. Health science centres, on the other hand, are organizations that coordinate the medical faculty, the various patient-oriented medical facilities, and the research centres (see Figure 2). They can fall



directly under the university or stand as a separate legal entity. Health science centres exist predominantly in the United States of America (e.g. the *UNM Health Sciences Center* in New Mexico).

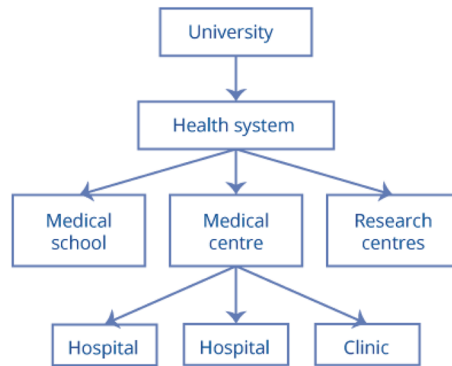


Figure 2. Health science centres.

It is important to note the difference between health science centres (as modelled in Figure 2) and academic health science networks such as the *Oxford Academic Health Science Network* in the United Kingdom. These health networks refer to partnerships between one or more universities, local governments, and industries that seek to improve innovation delivery times and patient services (Fish, 2013). We have found that health networks are rarely mentioned in publications; furthermore, we have found that they pursue varied interests and do not focus primarily on undergraduate education. Other networks such as the *Copenhagen University Hospital* in Denmark and the *University Health Network* in Canada refer to collaboration agreements between the regional health authorities and a university without institutionalized integration between the medical faculty and all the hospitals in said regions.

The third model refers to a relationship of collaboration and support between hospital and university in which the collaboration is structural rather than incidental: there are some shared activities between the two, but no full integration of the medical faculty into the hospital (see Figure 3). These types of relationships are the most common worldwide.

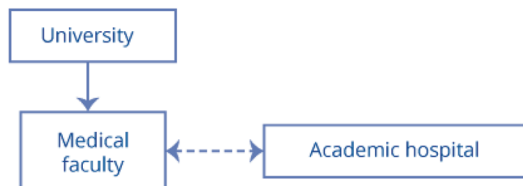


Figure 3. Collaboration and support.



2.2 The three-step workflow: identifying the relationship

Around the world, hospitals are referred to as “academic hospital”, “teaching hospital”, “university hospital”, “third-tier hospital”, and “academic medical centre” to denote some form of collaboration with a university; however, these nomenclatures do not constitute universally accepted definitions of specific types of hospital-university relationship, and thus can denote different things in different countries or even regions of the same country (Shi et al., 2021; Sato & Fushimi, 2012). Additionally, the level of collaboration between a university and a hospital may vary substantially between countries and regions, further rendering such labels unsuitable for global comparisons.

Sometimes the relationship between a hospital and a university may seem clear according to local perceptions. However, such local understandings of the interconnectedness between hospitals and universities cannot be used for international comparisons as they are not sufficiently consistent and demand specific local knowledge. On a similar note, some bibliometric databases assign affiliation between teaching/academic hospitals and universities based on local perceptions as communicated by each university to the database owner. This approach presents also shortcomings when doing international comparisons as it lacks consistency and depends on the client base of the various databases.

Following our previous work on academic hospitals (Praal et al., 2013), we at the Leiden Ranking have developed a three-step workflow to classify the relationship between universities and their affiliated hospitals. This workflow effectively transposes the three above-noted relationship models into the two types of instrumental relationships that the Leiden Ranking employs for the allocation of the publication output of academic hospitals. We distinguish between academic hospitals that are associated with universities (“associate”) and academic hospitals that can be considered as part of the university (“component”).

When a hospital and a medical faculty are fully integrated or when a hospital is part of a health science centre (see Figures 1 and 2) the relationship is classified as component. When a hospital follows the model of collaboration and support (see Figure 3) the relationship is classified as associate. Although distinct in their organizational structures, the full-integration and health science centre models suggest a strong integrated relationship concerning the tasks of education and research. In both cases the medical faculty is difficult to separate from the hospital; therefore we treat them in the same way. In the collaboration and support model this is not the case.

Although the proposed scheme cannot do justice to the myriad forms of integration that might exist, it seeks to address the complexity of the relationship between academic hospitals and universities. The scheme is pragmatic and focuses on three



aspects that can aid in evaluating the degree of interdependence: legal status, shared educational mandate, and level of physical integration (see Figure 4).

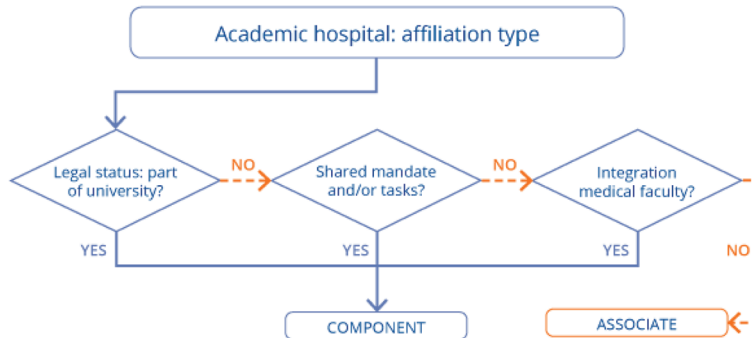


Figure 4. Three-step workflow.

2.2.1 First step

First, a hospital’s legal status is examined. If the ownership lies with the university or a foundation owned by or related to the university, the hospital is considered a component. In many cases, ownership can be easily determined for a whole country or region given specific health services regimes. For example, in the United Kingdom, hospitals and trusts that collaborate intensively with universities are owned by the *National Health Service*. In Poland, hospitals strongly connected to universities became part of the university structure by law in 2001. Thus according to this first step, hospitals in the United Kingdom cannot be considered as components, while academic hospitals in Poland should be considered as components of their universities.

For the first step in the workflow, not only the direct legal ownership is considered but also whether the hospital is part of a university health system. We find many cases like this in the United States of America. For example, the *Duke University Health System* comprises three hospitals, a medical faculty, and a series of outpatients’ clinics. *Northwestern Medicine* has a similar structure that comprises various hospitals, a medical school, and a comprehensive cancer centre. Notably, an organizational structure like that of Duke or Northwestern is significantly different from a health science network as mentioned above, where the affiliated university exercises no direct control over the management of hospitals, clinics, and medical faculties.

Some cases present a seemingly opposite ownership situation that nevertheless results in a classification as component. For example, the *Mount Sinai Health System* in the United States of America owns the *Icahn School of Medicine*. This medical school was previously considered as part of *City University of New York*



(1968–1998) and *New York University* (1999–2007) because these universities were granting its degrees until 2010; since then, *Mount Sinai* has been accredited as an independent degree-granting institution. Technically, the medical school belongs to the hospital group, yet for the Leiden Ranking’s practical purposes (publication count) the hospital group is seen as a component of the medical school.

2.2.2 Second step

The second step in the workflow examines a hospital’s mandate. Given the Leiden Ranking’s focus on universities, the tasks considered here are core-curriculum education and research. In general, every hospital affiliated with a university will conduct research, except for smaller clinics which solely provide clinical placements. A more difficult function to determine is the type of education provided by a hospital. Over all, we have found that hospitals provide different levels of education ranging from patient education (for example on nutrition), specialist training or continuous education, to core-curriculum education for undergraduate students. On some occasions, a hospital has a clear mandate to aid a university in the provision of undergraduate education, in which case the hospital is considered to act as a component of the university.

The mandate of a hospital is not always publicly available, although for some countries it is part of the national or regional legislation. In a few cases, the mandate is part of a hospital’s mission statement. For example, the *Centre hospitalier universitaire de Poitiers* in France mentions two types of education under its mission. The first type is referred to as “prevention and education”, and targets patients as well as professionals. The second type concerns education for students of the University of Poitiers’ medical faculty, including undergraduate education. In this case, although there is no mention of an explicit mandate, the hospital’s mission does seem to indicate that it should be considered as a component. In instances like this wherein the mandate is not sufficiently clear, a full assessment following the three-step workflow is necessary in order to definitively determine whether the university-hospital relationship is associate or component.

In some countries, we have observed a clear pattern in which public academic hospitals provide core education. However, it is possible that the wave of public-services privatization in those countries may influence the extent of educational tasks provided by hospitals, as privatized hospitals tend to become less involved with education. In Germany, for example, the majority of large academic hospitals are traditionally public and involved with core education, but as some of these hospitals have been recently privatized, not all German hospitals can be automatically considered as components of universities.



Often, information about hospitals' mandates is not available at all. For example, the *Turku University Hospital* is owned by the *Hospital District of Southwest Finland* and seems to only cover continuous education for specialists. For such cases, which are the majority, the assessment requires progressing to the next step of the workflow.

2.2.3 Third step

The third and final step of the workflow examines to what extent a hospital and medical faculty are integrated. This step covers two major elements: the physical location of the faculty and the publication behaviour of authors mentioning the hospital affiliation. For the former we consider whether the hospital and the medical faculty have shared locations. For the latter we examine whether the authors publishing for the hospital are members of the medical faculty.

When a hospital shares locations and staff with a medical faculty, it is considered a component of the university. As in the previous steps, the outcome of this review is rarely a binary yes-no. In some cases, the medical school or most of its departments will be located on the hospital grounds, indicating a tight physical integration. For example, the medical school of *University of Bari Aldo Moro* in Italy is located at the *Azienda Universitaria Ospedaliera Consorziale - Policlinico Bari*. Yet what we often find is that only one or two departments out of many are located at the hospital: usually pediatrics, gynaecology, clinical medicine, or nursing. Such is the case of *Hospital Clínico San Carlos* which houses the gynecology and obstetrics departments of the *Complutense University* in Spain. In those cases, we do not consider this as a tight physical integration.

With this complexity in mind, the third step also considers the publication behaviour of authors using the hospital affiliation: we examine a sample of publications comprising authors using the hospital affiliation without mentioning the university to which the hospital is supposedly affiliated. We then investigate whether those authors are formally employed by the university. For example, the majority of the authors from our sample who publish using the *Canberra Hospital* affiliation are employed by the *Australian National University*. It is a sign of strong interdependency when the majority of authors publishing for a hospital are also faculty members at its affiliated university.

2.2.4 Evaluating the three steps

When the workflow shows a low level of interdependency, we classify the relationship of the hospitals as that of associate to the university. As an example, a hospital owned by the regional health authority, without a clear mandate for core-curriculum education, with one or no university department located on the hospital



premises, and few authors publishing with the hospital's address who hold a faculty position, would be considered as associate. Such is the case of the *Institutul Clinic Fundeni* to the *Carol Davila University of Medicine and Pharmacy of Bucharest*.

It is worth emphasizing that this is not a straightforward process: often it is difficult or impossible to retrieve all the information necessary to complete the workflow, and even with all of the information, the results of the assessment may be ambiguous. Thus the decision of classifying the relationship as associate or component typically depends on a combination of the available information. Lastly, because of its resource-intensive nature, the assessment is only carried out for academic hospitals whose publication output surpasses a specific threshold.

3 Evaluating the relationship - difference in numbers

Determining the relationship model can have a substantial impact on the publication counts for universities (as shown in Table 1). For example, the *University Hospital Zurich* (UHZ) in Switzerland is affiliated with the *University of Zurich* (UZ). The hospital is a legal entity on its own and although its mandate also includes educational responsibilities, it is not clear if those responsibilities extend to core-curriculum education. Nevertheless, the medical faculty and the hospital present a tight integration regarding physical locations and author affiliations: many departments from the medical faculty are housed in hospital buildings, and the majority of authors who publish for the hospital hold a position at the university. University employees should include the university's address on their publication, yet despite efforts from university management encouraging authors to mention their affiliation, some do not. This is significant because if UHZ is treated as a component of UZ, its publication count increases by 20% (based on articles and reviews between 2017–2020), which highlights the importance of our categorizing exercise.

These differences in counting publications output are also evident in other cases. For example in Italy, the *Azienda Ospedaliero-Universitaria di Parma* raises the *University of Parma's* publication count by 13%. In some cases, the contrast can be even more significant: in France, classifying the *Centre Hospitalier Régional Universitaire de Tours* as a component of the *Université de Tours* raises the publication count by 31%. Not all instances show such a large contrast, although the difference can still be notable. The *Ottawa Hospital* in Canada (which includes the *Children's Hospital of Eastern Ontario*) raises the publication count of the *University of Ottawa* by 10%. In Greece, the *University Hospital of Ioannina* raises the publication count of the *University of Ioannina* by only 6%.



Table 1. Overview of the separate output per university and hospital as well as their combined output. The percentage shows the increase of publication count of the university when the hospital is included as a component.

Organization	Separate output	Combined output	Percentage
Université de Tours	3,463	4,525	31%
Centre Hospitalier Régional Universitaire de Tours	1,062		
University of Zurich	18,573	22,297	20%
University Hospital Zurich	3,724		
University of Parma	5,222	5,924	13%
Azienda Ospedaliero-Universitaria di Parma	702		
Complutense University of Madrid	12,908	14,300	11%
Hospital Clínico San Carlos	1,392		
University of Ottawa	14,959	16,474	10%
The Ottawa Hospital	949		
Children's Hospital of Eastern Ontario	566		
University of Ioannina	3,479	3,689	6%
University Hospital of Ioannina	210		
University of Turku	7,849	8,195	4%
Turku University Hospital	346		
Palacký University Olomouc	4497	4,620	3%
University Hospital Olomouc	123		
Australian National University	13,932	14,158	2%
Canberra Hospital	226		
University of Hong Kong	17,790	18,015	1%
Queen Mary Hospital, Hong Kong	225		
University of Buenos Aires	8,434	8,492	1%
Hospital de Clínicas José de San Martín	58		
University of New Mexico	8,138	8,179	0%
UNM Health Sciences Center	41		

Caption: Output figures are based on publications indexed for the SCIE, SSCI, and AHCI citation indexes as part of the Web of Science produced by Clarivate Analytics. Only core publications from 2017–2020 that were classified as articles or reviews have been taken into account.[Ⓞ] A publication has been counted as output of the university or hospital when at least one of the affiliations explicitly mentions the university or hospital or one of its components.[Ⓢ]

Notably, the discrepancy on publication assignments is not present for all universities. For example, the *Turku University Hospital* in Finland raises the count of *University of Turku* by 4%, while *University Hospital Olomouc* in the Czech Republic raises the count of *Palacký University Olomouc* by 3%. Several cases present an even lower increase, such is the case of the *Australian National University*

[Ⓞ] Please see the Leiden Ranking website for more information on the selection of publications (Leiden Ranking, 2021)

[Ⓢ] On the Leiden Ranking website this way of counting is denoted as ‘full counting method’ as opposed to the fractional counting method in which each affiliation in a paper receives only partial credit for a paper based on the proportion of the authors using that affiliation. Although the fractional counting method is the preferred counting method in the Leiden Ranking, for this paper we chose to use the full counting method as this method is more straightforward to understand and most university rankings only use this counting method. In the fractional counting method, differences between the separate output of a university and the output combined with the hospital tend to be larger as affiliations with academic hospitals often appear in papers alongside affiliations with the university.



in Australia as its count raises by 2% through the publications of the *Canberra Hospital*; while both the *University of Hong Kong* (Chinese Hong Kong) and the *University of Buenos Aires* (Argentina) see their count raised by 1%. In some cases, the differences are completely negligible, such as with the *University of New Mexico* in the United States of America. The *UNM Health Sciences Center* shows the characteristics of a component to the university, yet its publication output is so miniscule that it only raises the university's count by 0%.

4 Advantages and limitations of the approach

As mentioned above, this paper does not seek to provide a normative definition of an academic hospital rather than a pragmatic process for assigning publications with only a hospital address in university rankings. The three-step model allows for a standard approach that can facilitate comparison on the level of integration between hospitals and universities on a global scale in a fair and transparent manner.

Further, by managing the affiliation relationships through linkages instead of automatically cleaning hospital publications as those of the university, data can be disaggregated and analyzed at different levels and combinations. Likewise, the university-hospital linkage is not an obstacle to recognize other types of collaboration between those same institutions. For example, an academic hospital may be an associate of a university yet collaborate tightly with it on a research lab. If the research lab has a significant publication output it can be created as unit of analysis which is component to both the university and the academic hospital. Thus the different collaboration paths can be recognized without focusing solely on the output of one organization (Hicks & Katz, 1996).

The approach is not without issues, especially as the information necessary to assign the type of affiliation is not always available. Owing to the different information-seeking paths and a non-binary decision process, the model cannot be applied automatically. Being labour and time intensive may limit its application by other research organizations. Nevertheless this model is a step in an ongoing research on publication patterns of hospitals and universities.

As the model is not normative, we do not foresee any sort of policy implications for academic hospitals and universities. The risk that some organizations or regions may game the rankings by specifically rewriting mandates is a possibility. However, the implications for the organizations themselves would be considerable as such change would involve a whole administrative and budgetary adjustment. At the same time, being transparent on the processes to categorize organizations and their affiliations may help universities and academic hospitals to communicate their relationship more clearly to the outside world.



5 Conclusion

Building upon Praal et al.'s (2013) discussions on how to delimit universities with regard to academic hospitals for publication count, the Leiden Ranking proposes a characterization and methodology that allows us to evaluate the degree of integration between these two types of organizations. Although the methodology presented herein is somewhat arbitrary, employing these standards to compile data allows for a more balanced and fair comparison between worldwide educational and research systems, without losing disaggregated data at different levels.

The Leiden Ranking's current approach has some limitations. Firstly, it requires a resource-intensive assessment process. We have sought to streamline this process by setting a threshold of publications before submitting a hospital to the three-step review. Secondly, examining the relationships between universities and hospitals in countries with non-Latin-based alphabets poses a challenge and can be a disadvantage for those organizations that do not have comprehensive faculty websites in English or do not update their faculty pages often. Nevertheless, the model provides a standard approach for evaluating integration between these organizations.

To conclude, we would like to add that organizational structures will continue evolving in order to better respond to public and government expectations of accountability and efficiency, requiring our methodologies to evolve as well. The experience and knowledge acquired through the in-depth evaluation of academic hospitals following the three-step model, will allow us to follow these changes better.

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Author contributions

Reyes Elizondo, Andrea (a.e.reyes.elizondo@CWTS.leidenuniv.nl): Conceptualization (Equal), Formal analysis (Supporting), Investigation (Equal), Methodology (Lead), Visualization (Lead), Writing – original draft (Lead), Writing – review & editing (Equal); Calero-Medina, Clara (clara@cwts.leidenuniv.nl): Conceptualization (Equal), Methodology (Supporting), Project administration (Lead), Visualization (Supporting), Writing – original draft (Supporting), Writing – review &



editing (Equal); Visser, Martijn S. (visser@cwts.leidenuniv.nl): Conceptualization (Equal), Formal analysis (Lead), Investigation (Equal), Methodology (Supporting), Writing – review & editing (Equal).

References

- Altbach, P.G. (2004). Globalisation and the University: Myths and Realities in an Unequal World. *Tertiary Education and Management*, 10(1), 3–25. <https://doi.org/10.1023/B:TEAM.0000012239.55136.4b>
- Barrett, D.J. (2008). The Evolving Organizational Structure of Academic Health Centers: The Case of the University of Florida. *Academic Medicine: Journal of the Association of American Medical Colleges*, 83(9), 804–808. <https://doi.org/10.1097/ACM.0b013e318181d054>
- Birtwistle, T. (2003). What Is a “University”? (The English Patient). *Education and the Law*, 15(4), 227–236. <https://doi.org/10.1080/0953996042000182138>
- Bologna Working Group on Qualifications Frameworks (2005). *A Framework for Qualifications of the European Higher Education Area*, (pp. 59–74). Copenhagen: Ministry of Science, Technology and Innovation.
- Brennan, T.A., Rothman, D.J., Blank, L., Blumenthal, D., Chimonas, S.C., Cohen, J.J., Goldman, J., Kassirer, J.P., Kimball, H., Naughton, J., & Smelser, N. (2006). Health Industry Practices That Create Conflicts of Interest: A Policy Proposal for Academic Medical Centers. *JAMA*, 295(4), 429–433. <https://doi.org/10.1001/jama.295.4.429>
- Cohen, J.J., & Siegel, E.K. (2005). Academic Medical Centers and Medical Research: The Challenges Ahead. *JAMA*, 294(11), 1367–1372. <https://doi.org/10.1001/jama.294.11.1367>
- Daniels, R.J., & Carson, L.D. (2011). Academic Medical Centers—Organizational Integration and Discipline through Contractual and Firm Models. *JAMA*, 306(17), 1912–1913. <https://doi.org/10.1001/jama.2011.1606>
- Davies, S.M., Tawfik-Shukor, A., & de Jonge, B. (2010). Structure, Governance, and Organizational Dynamics of University Medical Centers in the Netherlands. *Academic Medicine*, 85(6), 1091–1097. <https://doi.org/10.1097/ACM.0b013e3181dbf915>
- Denman, B.D. (2005). What Is a University in the 21st Century?. *Higher Education Management and Policy*, 17(2), 9–28. <https://doi.org/10.1787/hemp-v17-art8-en>
- Dill, D.D. (2006). *Convergence and Diversity: The Role and Influence of University Rankings* [Keynote presented at the Consortium of Higher Education Researchers (CHER)] 19th Annual Research Conference, University of Kassel, Germany.
- Fish, D.R. (2013). Academic Health Sciences Networks in England. *The Lancet*, 381(9882), e18–e19. [https://doi.org/10.1016/S0140-6736\(12\)60866-6](https://doi.org/10.1016/S0140-6736(12)60866-6)
- French, C.E., Ferlie, E., & Fulop, N.J. (2014). The International Spread of Academic Health Science Centres: A Scoping Review and the Case of Policy Transfer to England. *Health Policy*, 117(3), 382–391. <https://doi.org/10.1016/j.healthpol.2014.07.005>
- Fuchs, V.R. (2013). Current Challenges to Academic Health Centers. *JAMA*, 310(10), 1021–1022. <https://doi.org/10.1001/jama.2013.227197>
- Gallin, J.I., & Smits, H.L. (1998). Managing the Interface Between Medical Schools, Hospitals, and Clinical Research. *Survey of Anesthesiology*, 42(1), 651–654. <https://doi.org/10.1001/jama.1997.03540320053035>



- Gaynor, M., Laudicella, M., & Propper, C. (2012). Can Governments Do It Better? Merger Mania and Hospital Outcomes in the English NHS. *Journal of Health Economics*, 31(3), 528–543. <https://doi.org/10.1016/j.jhealeco.2012.03.006>
- Griner, P.F., & Blumenthal, D. (1998). Reforming the Structure and Management of Academic Medical Centers: Case Studies of Ten Institutions. *Academic Medicine*, 73(7), 818–825. <https://doi.org/10.1097/00001888-199807000-00025>
- Hardeman, S. (2013). Organization Level Research in Scientometrics: A Plea for an Explicit Pragmatic Approach. *Scientometrics*, 94, 1175–1194. <https://doi.org/10.1007/s11192-012-0806-6>
- Hicks, D., & Katz S. (1996). Science policy for a highly collaborative science system. *Science and Public Policy*, 23(1), 39–44. <https://doi.org/10.1093/spp/23.1.39>
- Labi, A. (2011). University Mergers Sweep Across Europe. *The Global Chronicle*. Retrieved 26 March, 2019, from <http://www.chronicle.com/article/University-Mergers-Sweep/125781>
- Leiden Ranking (2021) *Information, Universities*. The CWTS Leiden Ranking. Retrieved 20 December, 2021, from <http://leidenranking.com/information/universities>
- Leiden Ranking (2021) *Indicators, Publications*. The CWTS Leiden Ranking. Retrieved 20 December, 2021, <https://www.leidenranking.com/information/indicators#publications>
- Levine, J.K. (2002). Considering Alternative Organizational Structures for Academic Medical Centers. *AAMC Academic Clinical Practice*, 14(2) 2–5.
- Lozon, J.C., & Fox, R.M. (2002). Academic Health Sciences Centres Laid Bare. *HealthcarePapers*, 2(3), 10–36. <https://doi.org/10.12927/hcpap.2002.17202>
- Nicholson, K., Randhawa, J., & Steele, M. (2015). Establishing the SouthWestern Academic Health Network (SWAHN): A Survey Exploring the Needs of Academic and Community Networks in SouthWestern Ontario. *Journal of Community Health*, 40(5), 927–939. <https://doi.org/10.1007/s10900-015-0015-3>
- Nonnemaker, L., & Griner, P.F. (2001). The Effects of a Changing Environment on Relationships between Medical Schools and Their Parent Universities. *Academic Medicine*, 76(1), 9–18. <https://doi.org/10.1097/00001888-200101000-00007>
- Praal, F.E.W., Kosten, M.J.F., Calero-Medina, C., & Visser, M.S. (2013). Ranking Universities: The challenge of Affiliated Institutes. In: S. Hinze & A. Lottmann (Eds.) *Proceedings of the 18th International Conference on Science and Technology Indicators: Translational Twists and Turns: Science as a Socio-Economic Endeavour*, Berlin, IFQ, 2013, pp. 284–289.
- Ovseiko, P.V., Heitmueller, A., Allen, P., Davies, S.M., Wells, G., Ford, G.A., Darzi, A., & Buchan, A.M. (2014). Improving Accountability through Alignment: The Role of Academic Health Science Centres and Networks in England. *BMC Health Services Research*, 14, 24. <https://doi.org/10.1186/1472-6963-14-24>
- Rochford, F. (2006). Is There Any Clear Idea of a University?. *Journal of Higher Education Policy and Management*, 28(2), 147–158. <https://doi.org/10.1080/13600800600750988>
- Rothman D.J., & Chimonas, S. (2010). Academic Medical Centers' Conflict of Interest Policies. *JAMA*, 304(20), 2294–2295. <https://doi.org/10.1001/jama.2010.1714>
- Sato, D., & Fushimi, K. (2012). Impact of Teaching Intensity and Academic Status on Medical Resource Utilization by Teaching Hospitals in Japan. *Health Policy*, 108(1), 86–92. <https://doi.org/10.1016/j.healthpol.2012.08.021>



Research Paper

- Shi, H.M., Fan, M., Zhang, H., Ma, S.Y., Wang, W.X., Yan, Z.G., Chen, Y.D., Fan, H.J., & Bi, R. (2021). Perceived health-care quality in China: a comparison of second- and third-tier hospitals. *International journal for quality in health care: journal of the International Society for Quality in Health Care*, 33(1), mzab027. <https://doi.org/10.1093/intqhc/mzab027>
- Wartman, S.A. (2015). The Academic Health Center in a Disrupted World. *The Pharos of Alpha Omega Alpha-Honor Medical Society*, 78(2), 2–9.
- Wartman, S.A. (2008). Toward a Virtuous Cycle: The Changing Face of Academic Health Centers. *Academic Medicine*, 83(9), 797–799. <https://doi.org/10.1097/ACM.0b013e318181cf8c>
- Wartman, S.A., Hillhouse, E.W., Gunning-Schepers, L., & Wong, J.E.L. (2009). An International Association of Academic Health Centres. *The Lancet*, 374(9699), 1402–1403. [https://doi.org/10.1016/S0140-6736\(09\)61594-4](https://doi.org/10.1016/S0140-6736(09)61594-4)
- Washington, A., Coye, M.J., & Feinberg, D.T. (2013). Academic Health Centers and the Evolution of the Health Care System. *JAMA*, 310(18), 1929–1930. <https://doi.org/10.1001/jama.2013.282012>
- Wijgert, J. van de. (2010). Academic Health Science Systems. *The Lancet*, 375(9728), 1782. [https://doi.org/10.1016/S0140-6736\(10\)60807-0](https://doi.org/10.1016/S0140-6736(10)60807-0)
- Zinner, D.E., & Campbell, E.G. (2009). Life-Science Research within US Academic Medical Centers. *JAMA*, 302(9), 969–976. <https://doi.org/10.1001/jama.2009.1265>



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