

A substantial number of scientific publications originate from non-university hospitals

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ABSTRACT

INTRODUCTION: As we found no recent published reports on the amount and kind of research published from Danish hospitals without university affiliation, we have found it relevant to conduct a bibliometric survey disclosing these research activities.

MATERIAL AND METHODS: We retrieved all scientific papers published in the period 2000-2009 emanating from all seven Danish non-university hospitals in two regions, comprising 1.8 million inhabitants, and which were registered in a minimum of one of the three databases: PubMed MEDLINE, Thomson Reuters Web of Science and Elsevier's Scopus.

RESULTS: In 878 of 1,252 papers, the first and/or last author was affiliated to a non-university hospital. Original papers made up 69% of these publications versus 86% of publications with university affiliation on first or last place. Case reports and reviews most frequently had authors from regional hospitals as first and/or last authors. The total number of publications from regional hospitals increased by 48% over the 10-year period. Publications were cited more often if the first or last author was from a university hospital and even more so if they were affiliated to foreign institutions. Cardiology, gynaecology and obstetrics, and environmental medicine were the three specialities with the largest number of regional hospital publications.

CONCLUSION: A substantial number of scientific publications originate from non-university hospitals. Almost two thirds of the publications were original research published in international journals. Variations between specialities may reflect local conditions.

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TRIAL REGISTRATION: not relevant.

Danish health research ranks highly in international bibliometric surveys, both in terms of the number of scientific publications and the number of citations per one million inhabitants [1]. In a Danish survey from 1988-1992, Gøtzsche et al reported that 75% of all retrieved scientific health-related publications came from universities or university related hospitals, whereas approximately 12% came from regional hospitals [2]. University hospitals tend to study highly select cases with rare or complicated diseases, and study results may not be valid

in less select populations of patients. There are no recently published reports on the amount and kinds of research derived from Danish regional hospitals defined as hospitals without a university affiliation. Because familiarity with research is an important prerequisite for treatment at the most updated level, it is important that regional hospitals participate in clinical research [3].

Bibliometric surveys are often used as a proxy measure for outcome and citation analysis is a standard procedure to assess the relevance or importance of an individual paper [4-6].

We therefore find it of interest to focus on research activities from regional hospitals and we here report a survey of the number and impact in terms of citations of scientific papers published from Danish regional hospitals in the period 2000 to 2009.

MATERIAL AND METHODS

Geography

The survey was conducted in two Danish regions (Region Central Jutland and Region North Jutland) with a total of 1.8 million inhabitants including all regional hospital units (seven hospital units in total). Due to the fusion of hospitals and hospital units during the observation period from 2000 to 2009, all names of current and former hospitals were identified and added to the search queries (Appendix A). Private hospitals constituted only a minority of health care providers in Denmark and were not included in the analysis.

Data collection

Data were retrieved from searches in the following three bibliographic databases: PubMed (MEDLINE), Thomson Reuters Web of Science (WoS), and Elsevier's Scopus. All three databases were employed to retrieve the most complete dataset for all hospitals. Only publications retrieved by querying each of these three databases were included in the study. To ensure reproducibility, we included no papers not identified in the electronic search. All queries were delimited to publication dates between 1 January 2000 and 31 December 2009, and there were no language limitations. Search queries were formulated to target the address or affiliation fields in each database. The exact formulation of each query and the re-

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 TABLE 1

Number of publications (%) from regional hospitals according to affiliation of first or last author to either a regional (Group A) or a Danish university/university hospital (Group B)^a.

	Group A (n = 878)	Group B (n = 574)	Total (n = 1,252)
<i>Type of research</i>			
Clinical research	729 (83)	484 (84)	1,050
Experimental research	94 (11)	69 (12)	137
Miscellaneous	55 (6)	21 (4)	65
<i>Type of publication</i>			
Original paper	608 (69)	493 (86)	928
Review	98 (11)	40 (7)	120
Case report	117 (13)	27 (5)	138
Other	55 (6)	14 (2)	66
<i>Language</i>			
Danish	255 (29)	46 (8)	282
English	620 (71)	528 (92)	965
Other	3 (-)	0	5
<i>Pharmaceutical support</i>			
Yes	41 (5)	63 (11)	114
No	766 (87)	469 (82)	1,031
Unclear	71 (8)	42 (7)	107

a) As the A and the B columns are not mutually exclusive and there were additional references not classified as either regional or university hospitals, the sum of all publications is different from the sum of Group A and Group B publications.

sultant size thereof can be seen in Appendix A. In WoS and Scopus, all queries were delimited with regard to publication type, including only original articles, reviews, notes and letters.

Data refinement

Certain overlaps exist among PubMed, WoS and Scopus which implies a number of duplicate entries. These were combined algorithmically, using a stepwise matching process. Initial matching was performed on Digital Object Identifiers (DOI) followed by matching based on a combination of International Standard Serial Number (ISSN), volume, issue and pagination of journal publications and, finally, based on titles (fuzzy logic matching). Title matching was reviewed manually to prevent matching errors. Duplicates identified in this process were merged to contain combined citation data from the matching databases because citation data are not included in PubMed and may differ in WoS and Scopus [7].

Manual assessment of individual publications

A full text version of each paper was distributed for review by the authors and categorized as follows: 1) Affiliation of the first and/or last authors to: a) one of the regional hospitals (Group A), b) a Danish university/university hospital (Group B), c) an academic institution outside Denmark (Group C) and/or d) other affiliation,

e.g. pharmaceutical company or private practice (Group D). These entries were not mutually exclusive. 2) Speciality was classified into 37 individual health care specialities as defined by the Danish Board of Health in 2010 [8]. 3) Type of research classified as: a) clinical research if the study population was patients, b) experimental research if the study population included healthy subjects, animal research, in vitro studies, etc., or c) other. 4) Language of the full publication (irrespective of the language of the abstract) was classified as: a) Danish, b) English or c) other. 5) Type of publication was assessed based on the contents and recorded as: a) original paper, b) review, c) case report (with a maximum of five patients if not classified as an original paper) or d) other (including correspondences and letter to the editor). 6) Financial support by pharmaceutical companies were noted if the list of authors included an affiliation to a company, the study medication was granted by a company or a pharmaceutical company was acknowledged for support. Publications wrongly retrieved as originating from a regional hospital were removed from the final list of papers during the review process.

Normalizations of citations of publications

We assessed the impact of the publications from the regional hospitals by means of citations from WoS and Scopus. For each publication, we used the highest citation number from one of the two databases. Item-normalized median citation scores were used to adjust for the year of publication [9]. A normalized citation score of 1.0 reflects a median citation frequency for a given publication year. We did not remove self-citations from the data.

Trial registration: not relevant.

RESULTS

The queries resulted in 1,437 records from Scopus, 1,123 records from WoS and 915 records from PubMed. After removing overlap from co-authoring hospitals and automatic duplicate matching, 1,692 records remained. The manual duplicate matching and the removal of erroneously retrieved records left 1,252 records for analysis. In 878 cases, the first and/or the last author was affiliated to a regional hospital (Group A) and in 574 cases the first and/or last author was from a Danish university or a university hospital (Group B; **Table 1**). The two categories were not exclusive, as a publication could have a first author from a regional hospital and a last author from a Danish university or vice versa.

Overview of publication types

The proportions of clinical studies and experimental research did not differ between Group A (83% and 11%)

and Group B (84 % and 12%). Original papers represented 69% of Group A publications versus 86% of Group B publications. Most publications were in English language, with publications in Danish representing 29% of Group A publications and 8% of Group B publications. In 126 publications, the first or last authors came from institutions in other countries (Group C), 49 of these also had a first or last author from a regional hospital and 23 from a university hospital. The proportion of trials with pharmaceutical support was twice as high in publications with university affiliation as in those originating solely from regional hospitals (11% versus 5%).

Publication number and citations

The annual number of publications increased by 48% (from 122 to 180) (**Figure 1**) over the course of the study period. The number of Group A publications rose by 12%, whereas Group B publications increased by 124% (from 42 to 94) and 113% (from 8 to 17) over the period, respectively.

The item-normalized citation score is shown in **Figure 2** as a box-and-whiskers plot. The box summarizes the distribution of data, while the whisker plot shows the spread of the data illustrated as upper quartile, lower quartile and interquartile range. The median citation score was 0.5 for Group A, 1.0 for Group B and 1.7 for Group C, respectively.

Publication activity grouped per medical specialities

Medical specialities with a minimum of 20 publications during the ten-year period are listed in **Figure 3**. The bar length for each speciality represents the total number of publications and it is subdivided into publications with first or last author affiliated to a regional hospital (Group A) and the difference to the total. The difference represents Group B and C publications minus the overlap with publications from the first bar. Cardiology, gynaecology and obstetrics, and environmental medicine are the three specialities with the largest number of publications. The proportion of Group A publications varied considerably from 17% in infectious medicine to 91% in orthopedic surgery and nephrology.

DISCUSSION

In Denmark, a substantial number of scientific publications originate from regional hospitals. Almost two thirds of the publications were original research published in international journals. Publications were cited more often if the first or last author was from a university hospital and citations increased even more so if these authors were affiliated to foreign institutions.

We did not include articles found by hand search, articles found in annual reports from the hospitals or articles found by scrutinizing reference lists from re-

trieved papers. Therefore, our search probably does not provide a complete picture of all publications originating from regional hospitals. Likewise, the completeness may have been higher if we had included additional databases. Despite this drawback regarding completeness,

FIGURE 1

The annual number of publications from 2000 to 2009 from regional hospitals in two Danish regions. Publications were further classified as Group A ("Regional") if the first and/or last author was affiliated with a regional hospital. Likewise, Group B ("University") and C ("International") required that the first and/or last author was affiliated with a Danish university/university hospital or a foreign hospital or research institution, respectively. The affiliation classification was not mutually exclusive.

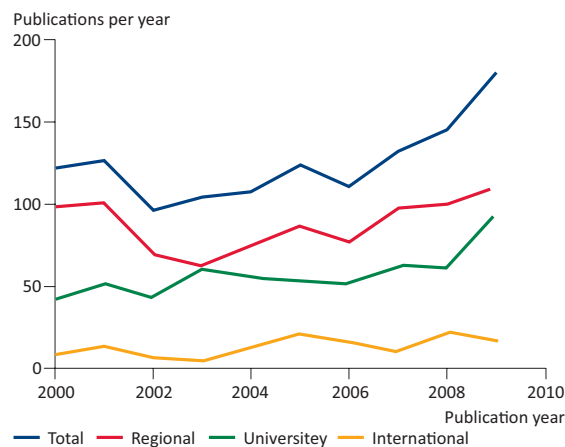


FIGURE 2

Box-and-whiskers plot of item-normalized citation score of publications with first or last author affiliated to either a regional hospital (median 0.5; interquartile range: 0.0-1.7), a university or university hospital (median 1.0; interquartile range: 0.0-2.7). "International" (median 1.7; interquartile range: 0.4-5.4) denotes first or last authors affiliated a foreign hospital or research institution. For sake of graphical presentation, we have omitted outliers with citation scores above 12 (seven from regional and ten from university hospitals).

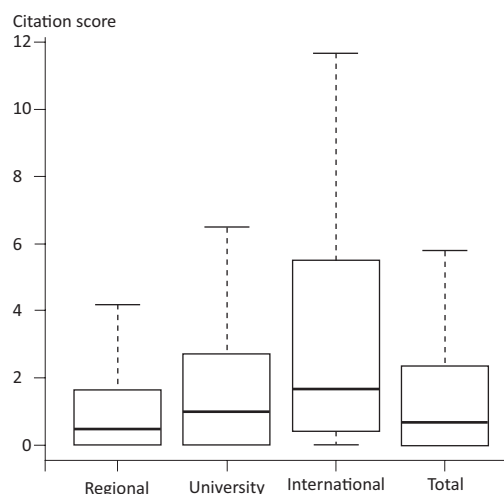
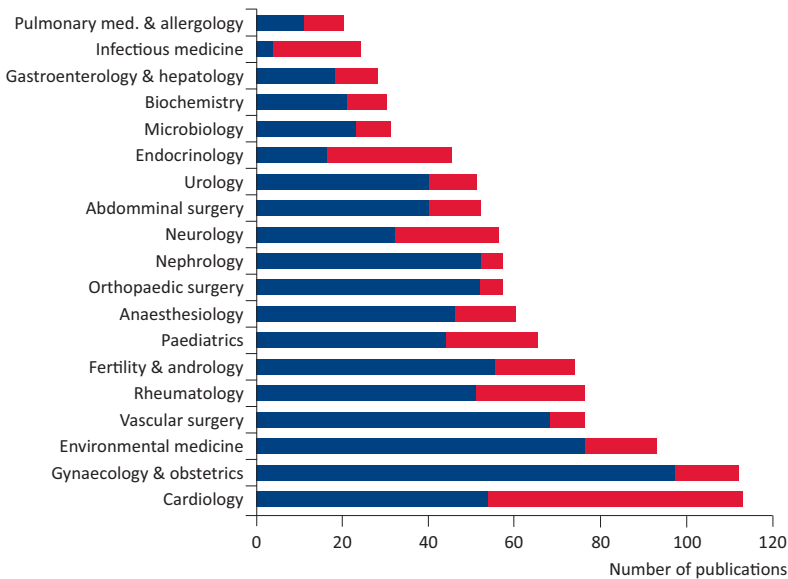



FIGURE 3

Publications from medical specialties with more than 20 publications from 1990 to 2009. The blue column represents the number of publications with first and/or last author affiliated to a regional hospital (Group A) and the red column represents publications where the first and/or last author was affiliated to a Danish university/university hospital or an international institution minus the overlap with Group A.



we find that our query design enjoys provides a major strength as it secures reproducibility and allows uniform reassessment at a later time. Individual assessment of each publication ensured the correct categorization of the papers. We were not able to perform a detailed assessment of all publications from the universities and university hospitals within the region. Therefore, we cannot compare the number of publications from regional hospitals with the total number of publications from the region.

The use of citation indices to evaluate the impact of publications is heavily debated [4, 5, 10, 11]. The scope of our analysis was not to assess the absolute quality of the published research, but rather to compare “regional hospital publications” in which the key authors were affiliated with regional or university hospitals. As we included very recent publications (up to 2009), a fixed citation window would necessarily be very short and would not necessarily be representative. Thus, we normalized citations with respect to publication year. This normalization prevents time bias and allows comparison of citations with different citation windows.

We find it noteworthy that the distribution of clinical versus experimental research is equal for Group A and B. This indicates that regional hospitals participate in the same spectrum of research as university hospitals. The larger number of case reports published in Group A is likely to have a negative impact on the citation scores

because this study design has been shown to be significantly less cited than other types of research [12, 13]. This impact may explain the difference in median normalized citation score between the groups in Figure 2. Also, the relative proportion of very often cited Group C publications affects this difference.

According to our data, publication activity varies widely among specialties. This result may reflect local conditions; certain departments are not represented at all at regional hospitals while others have a long and well-established tradition for research. The observed distribution among specialties may therefore not apply to other regions.

We have previously shown that the financial support of research activities at regional hospitals is modest [14]. Despite this finding, our present survey demonstrates that regional hospitals contribute to the international scientific society with a substantial amount of highly ranked clinical research publications. It is evident that regional hospitals have medical staffs willing and able to conduct research. It is reasonable to assume that providing additional research funding for regional hospitals would lead to an increase in scientific activities. This would be important for several reasons: 1) the majority of “ordinary” diseases are treated at regional hospitals; thus, research into these conditions should rightfully be conducted where these patients are; 2) the effects of treatments evaluated at university hospitals may not be generalized to regional hospitals, as the case-mix of patients at each facility is different; 3) participation in research will strengthen the academic milieu at regional hospitals; new treatment modalities will disseminate more quickly to departments participating in frontline research; and 4) opportunities to participate in research will most likely make it easier to attract and retain young doctors at regional hospitals. The organization of hospitals and the recruitment of doctors to the hospitals at all five Danish regions are very similar. We therefore believe that our results can be generalized to all regional hospitals.

In conclusion, we have demonstrated that seven regional hospitals in two Danish regions contribute with a substantial amount of well-ranked clinical research publications.

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