Publications of the Academy of Finland 5/09

Clinical Research in Finland and Sweden

Evaluation Report

Academy of Finland
Research funding and expertise

Vetenskapsrådet

Publications of the Academy of Finland 5/09

Clinical Research in Finland and Sweden

Evaluation Report

Academy of Finland in Brief

The Academy's mission is to finance high-quality scientific research, act as a science and science policy expert and strengthen the position of science and research. The Academy's activities cover all scientific disciplines.

The main focus of the Academy's development activities is on improving opportunities for professional careers in research, providing resources and facilities for high-profile research environments and making the best possible use of international opportunities in all fields of research, research funding, and science policy.

The Academy has a number of funding instruments for various purposes. In its research funding, the Academy of Finland promotes gender equality and encourages in particular women researchers to apply for research posts and research grants from the Academy.

The Academy's annual research funding amounts to more than 287 million euros, which represents some 15 per cent of the government's total R&D spending.

Each year Academy-funded projects account for some 3,000 researcher-years at universities and research institutes.

The wide range of high-level basic research funded by the Academy generates new knowledge and new experts. The Academy of Finland operates within the administrative sector of the Ministry of Education and receives its funding through the state budget.

For more information on the Academy of Finland, go to www.aka.fi/eng.

Swedish Research Council in Brief

In 2001, the Swedish Parliament passed legislation setting up the Swedish Research Council. The Swedish Research Council allocates support for Swedish basic research, with an emphasis on attending the highest quality and bringing about development and renewal. The Swedish Research Council is the largest state body providing funds for basic research in Sweden.

The Swedish Research Council is headed by a Board and a Director General. The Research Council also has an Executive Director who leads and co-ordinates the internal organization. Within the Research Council there are separate decision-making bodies for the different academic disciplines, led by Secretary Generals of advanced academic competence:

- Scientific Council for Humanities and Social Sciences
- Scientific Council for Medicine
- Scientific Council for Natural and Engineering Sciences
- Committee for Educational Science
- Committee for Research Infrastructure

The Swedish Research Council advises the Government in matters relating to research policy. It is also engaged in strategic issues concerning research and research funding in a national and international perspective. The Swedish Research Council has an overarching responsibility for ensuring that attention is paid to ethical issues in research. The Council also works for enhanced gender equality in the research community and promotes the adoption of a gender perspective in research contexts.

Page layout: DTPage Oy
ISBN 978-951-715-733-9 (print)
ISBN 978-951-715-734-6 (pdf)
Edita Prima, 2009

Contents

Description

Publisher	Academy of Finland	Date: May 2009
Author(s)	Evaluation Panel	
Title	Clinical Research in Finland and Sweden. Evaluation report	

Abstract

The report presents the results of the evaluation of clinical medical research carried out in Finland and Sweden. In Finland, the evaluation covered the Medical Faculties at the universities of Helsinki, Kuopio, Oulu, Tampere and Turku and in Sweden, the Medical Faculties at the universities of Lund, Umeå and Uppsala, the Faculty of Health Sciences at the University of Linköping, the Karolinska Institute and the Sahlgrenska Academy at the University of Gothenburg, as well as the corresponding university hospitals.

The evaluation panel states in its report that clinical research in both countries holds a high international standard. In an international comparison, both countries are above the average and some bigger units are world-leading. Even though there are differences between clinical research and health care systems in Finland and Sweden, the panel observed surprisingly many similarities between the two countries.

The evaluation panel lists several aspects that should be specifically considered in both countries in order to maintain clinical research at its high international level. The number of publications has not increased in either country over the last years, the research career is not attractive to young researchers, combining research and clinical work has become more difficult and operating models for technology transfer have not been completely established.

The panel proposes that the structure of education for clinical researchers be radically reformed in the near future in order to attract talented researchers to a research career as early as possible. As clinical work is an essential part of clinical research, structural measures are also needed to facilitate the combination of clinical work and research in the future. The base for research funding should be expanded in the long run and funding should principally be allocated on the basis of research merits. A clear strategy for the management of research work should be formulated at the university hospitals, in order to establish the position of research at all operational levels. Different units should strive to cooperate regarding e.g. research infrastructures and technology transfer so that recourses are utilized efficiently. Researcher mobility should be improved and structures impeding mobility changed. Both sexes should have equal prospects of success as clinical researchers. Administrative structures should be reorganized to diminish bureaucracy. The panel also proposes that the units create tools to evaluate the success of actions that are taken as a consequence of the recommendations of this evaluation.

Key words	medicine, clinical research, funding, researcher training, research career, health careservice system, technology transfer, university hospital, mobility	
Name and number of series	Publication of the Academy of Finland 5/09	
ISSN	0358-9153	
ISBN	Print: 978-951-715-733-9	Pdf: 978-951-715-734-6
Number of pages	84 p.	
Distributed by	Academy of Finland, POB 99, FI-00501 Helsinki, viestinta@aka.fi	
Published by	Academy of Finland	
Place and date of printing	Edita Prima, 2009	
Other information	www.aka.fi/publications	

Kuvailulehti

Julkaisija	Suomen Akatemia	Päivämäärä Toukokuu 2009
Tekijä(t)	Arviointipaneeli	
Julkaisun nimi	Suomen ja Ruotsin kliinisen lääketieteen tutkimuksen arviointi	
Tiivistelmä	Raportti esittelee Suomen ja Ruotsin kliinisen lääketieteellisen tutkimuksen arvioinnin. Arviointiin osallistuivat Suomessa Helsingin, Kuopion, Oulun, Tampereen ja Turun yliopistojen lääketieteelliset tiedekunnat ja Ruotsissa Lundin, Uumajan ja Uppsalan yliopistojen lääketieteelliset tiedekunnat, Linköpingin yliopiston terveystieteellinen tiedekunta, Karoliininen Instituutti ja Göteborgin yliopiston Sahlgrenska Akademi sekä vastaavat yliopistosairaalat. Arviointipaneeli toteaa raportissaan, että kliininen tutkimus on molemmissa maissa kansainvälisesti korkeatasoista. Molemmat maat sijoittuvat kansainvälisessä vertailussa keskitason yläpuolelle ja jotkut suurimmista yksiköistä lähelle maailman huippua. Vaikka Suomen ja Ruotsin kliinisessä tutkimuksessa ja terveydenhuollossa onkin paljon eroavaisuuksia, paneeli havaitsi evaluoinnissa hämmästyttävän paljon yhtäläisyyksiä maiden välillä. Arviointipaneeli listaa raportissaan useita seikkoja, joihin molemmissa maissa tulisi kiinnittää erityistä huomiota, jotta kliinisen tutkimuksen taso pystytään säilyttämään kansainvälisesti korkealla tasolla. Julkaisumäärät eivät kummassakaan maassa ole viime vuosina kasvaneet, tutkijanura ei houkuttele nuoria tutkijoita, akateemisen tutkimuksen ja kliinisen työn yhdistäminen on vaikeutunut ja teknologiansiirto ei ole kauttaaltaan vakiintunutta toimintaa. Paneeli esittääkin, että lääkäri-tutkijoiden koulutuksen rakenteisiin olisi tehtävä lähivuosina radikaaleja muutoksia, jotta lahjakkaat tutkijat saataisiin aloittamaan tutkijanura mahdollisimman aikaisessa vaiheessa. Koska kliininen työ kuuluu oleellisesti kliiniseen tutkimukseen, tarvitaan rakenteellisia toimenpiteitä myös siihen, että tutkimus- ja kliininen työ voidaan tulevaisuudessa tehokkaasti yhdistää. Tutkimusrahoituksen pohjaa tulisi laajentaa pitkäjänteisesti ja rahoituksen saannin tulisi pääsääntöisesti perustua tutkimusansioihin. Yliopistosairaaloiden tutkimuksen johtamiselle on luotava selkeä strategia niin, että tutkimuksen asema vakiintuu toiminnan kaikilla tasoilla. Eri yksiköiden tulisi pyrkiä yhdistämään voimiaan mm. tutkimusinfrastruktuurin ja teknologiansiirron osalta niin, että resurssien hyödyntäminen olisi tehokasta. Tutkijaliikkuvuutta tulisi parantaa ja liikkuvuutta rajoittaviin rakenteisiin tulee puuttua. Molemmille sukupuolille on luotava yhtäläiset mahdollisuudet menestyä kliinisellä tutkijanuralla. Hallinnollisia rakenteita on muutettava byrokratian vähentämiseksi. Paneeli myös esittää, että tämän arvioinnin suositusten toteuttamisen seurantaa varten yksiköiden kannattaisi luoda työkalu tehtyjen toimenpiteiden onnistumisen arvioimiseksi.	
Asiasanat	lääketiede, kliininen tutkimus, rahoitus, tutkijakoulutus, tutkijanura, terveydenhuolto, teknologiansiirto, yliopistosairaala, liikkuvuus	
Julkaisusarjan nimi ja numero	Suomen Akatemian julkaisuja 5/09	
ISSN	0358-9153	
ISBN	Painetulle kirjalle annettu tunnus 978-951-715-733-9	Pdf-versiolle annettu tunnus 978-951-715-734-6
Sivumäärä	84 s.	
Julkaisun jakaja	Suomen Akatemia, PL 99, 00501 Helsinki, viestinta@aka.fi	
Julkaisun kustantaja	Suomen Akatemia	
Painopaikka ja -aika	Edita Prima, 2009	
Muut tiedot	www.aka.fi/julkaisut	

Presentationsblad

Utgivare	Finlands Akademi	Datum Maj 2009
Författare	Utvärderingspanelen	
Titel	Utvärderingen av den kliniska medicinska forskningen i Finland och Sverige	
Sammandrag	Rapporten presenterar utvärderingen av den kliniska medicinska forskningen i Finland och Sverige. I Finland deltog de medicinska fakulteterna vid universiteten i Helsingfors, Kuopio, Uleåborg, Tammerfors och Åbo i utvärderingen och i Sverige de medicinska fakulteterna vid Lunds, Umeå och Uppsala universitet, Hälsouniversitetet vid Linköpings universitet, Karolinska Institutet och Sahlgrenska Akademin vid Göteborgs universitet, samt respektive universitetssjukhus. Utvärderingspanelen konstaterar i sin rapport att den kliniska forskningen i båda länderna håller hög internationell standard. I en internationell jämförelse placerar sig båda länderna över genomsnittet och några större enheter nära världstoppen. Även om det finns olikheter mellan den kliniska forskningen och hälsovården i Finland och Sverige, observerade panelen förvånansvärt många likheter länderna emellan. Panelen presenterar i sin rapport flera aspekter som särskilt borde uppmärksammas i de båda länderna för att kunna bibehålla den kliniska forskningens höga internationella standard. Under de senaste åren har antalet publikationer inte ökat i någotdera landet, forskarkarriären attraherar inte unga forskare, att förena forskning och kliniskt arbete har blivit allt svårare och verksamhetsformer kopplade till teknologiöverföring har inte genomgående befästs. Panelen rekommenderar att strukturen för utbildningen av forskarläkare borde förändras radikalt inom de närmaste åren så att begåvade forskare kunde slå in på forskarbanan i ett så tidigt skede som möjligt. Eftersom det kliniska arbetet utgör en väsentlig del av den kliniska forskningen, krävs strukturella åtgärder även för att i framtiden bereda forskare en möjlighet att effektivt kombinera forskning och kliniskt arbete. Forskningsfinansieringens underlag borde breddas långsiktigt och finansieringen borde i huvudsak grunda sig på forskningsmeriter. Universitetssjukhusen bör skapa en klar forskningsstrategi, så att forskningens ställning befästs på alla nivåer inom verksamheten. Olika enheter bör sträva till att samarbeta kring bl.a. forskningsinfrastrukturer och teknologiöverföring, så att utnyttjandet av resurserna kan effektiveras. Forskarnas mobilitet bör förbättras och strukturer som begränsar mobiliteten åtgärdas. Båda könen bör beredas lika möjligheter till framgång inom den kliniska forskningen. Administrativa strukturer bör förändras för att minska byråkratin. Panelen framhåller också att enheterna borde skapa redskap för att kunna utvärdera framgången hos de åtgärder som förverkligats på basen av rekommendationer presenterade i denna utvärdering.	
Nyckelord	medicin, klinisk forskning, finansiering, forskarutbildning, forskarkarriär, hälsovård, teknologiöverföring, universitetssjukhus, mobilitet	
Seriens namn och nummer	Finlands Akademis publikationer 5/09	
ISSN	0358-9153	
ISBN	ISBN-nummer för bokversionen 978-951-715-733-9	ISBN-nummer för pdf-versionen 978-951-715-734-6
Sidoantal	84 s.	
Distributör	Finlands Akademi, PB 99, 00501 Helsingfors, viestinta@aka.fi	
Förlag	Finlands Akademi	
Tryckort och -datum	Edita Prima, 2009	
Övriga uppgifter	www.aka.fi/publikationer	

Preface

Collaboration between individual researchers and research groups in Sweden and Finland has been increasing steadily during the last decades. Different research efforts have been launched either at Nordic level or as part of a larger international collaboration. In addition, collaboration between the Academy of Finland and the Swedish Research Council has also included more formal processes, such as evaluation of research grants.

In 2008, the Scientific Council of Medicine within the Swedish Research Council, the governmental Inquiry Commission of Clinical Research in Sweden, and the Research Council for Health of the Academy of Finland initiated an evaluation of the status of clinical research in Sweden and Finland. The study was conducted during November 2008–March 2009 by an international panel of senior clinical researchers.

Clinical research is a prerequisite for successfully translating experimental basic research into improved health care and disease prevention. Indications showed that both Sweden and Finland were facing similar problems in maintaining their previous strong position in clinical research, which has been a flagship for medical research in both countries. Therefore, the aim of the evaluation was primarily to obtain an objective expert opinion about the status of clinical research in both countries, and to reveal possible current trends in quantity and quality of clinical research in a global perspective. The second aim was to identify major obstacles and bottlenecks which may disturb or even prevent further development of clinical research, "which is dependent not only on the performance of academia but to a large extent also on the general attitude of the national health care system towards medical research". The third aim was to obtain a strategic view of the future development of the quality of clinical research in both countries that could form the basis for an action plan for the government and other responsible parties.

The results of the evaluation panel's study show a high international level of clinical research both in Sweden and Finland. However, it also reveals several alarming signals. The bibliometric analysis reveals a clear trend that Sweden's previous pre-eminence and research output is declining. More importantly, the evaluation panel presents a major concern of a widespread perception that the previous favorable circumstances for clinical research are rapidly eroding.

The Evaluation Panel presents several recommendations to stop this deteriorating development in order to retain the major benefits of high-quality clinical research that are essential to the citizens, the healthcare systems and the national economies. The great potential of Sweden's and Finland's clinical research must be stimulated and fully utilized for our future. Hence, long-term actions are required if we want to re-capture our relative competitive edge in clinical research. "The governments of both countries are committed to promoting research and innovation as the cornerstones of their strategy in an increasingly competitive world. Given the current international status of clinical research, and the exceptionally favorable conditions for its future success, it is up to decision-makers to establish the flexible legal framework and guarantee the financial well-being of this important field of science."

The Steering Group expresses its deepest gratitude to all members of the Evaluation Panel for their excellent work, especially to the Chair of the Panel Professor Roger Bouillon and Vice Chairs Professor Lisbeth Tranebjærg and Professor Tom Stossel.

Members of the Steering Committee

Håkan Billig
Kari Raivio
Olle Stendahl
Kalervo Väänänen

Executive Summary

In 2008, the Academy of Finland and the Swedish Research Council jointly convened an international panel of senior clinical researchers to review the status of clinical research in universities residing in the respective countries. This review was not an in-depth compilation of specific research activities and productivity, but rather a more general overview to biopsy the clinical research environment of the universities and acquire a general sense of the way in which human capital driving clinical research is being mobilized, trained and supported. The reviewers, deployed in three groups consisting of four members each and a chair, were assigned for review a total of 11 institutions equally divided among the groups, so that each group reviewed one or two Finnish and two Swedish centers. The visitors received a bibliometric analysis of the research productivity in the two countries generated by the Swedish Research Council, documents prepared by the administrations of the centers responding to specific questions regarding their self-assessment of activities, strengths and weaknesses in clinical research as well as additional material of variable content describing the different centers. The three committees then paid one-day visits to the assigned centers where they interviewed, in order, senior administrators, technology transfer personnel, senior and junior faculty and then regrouped with the senior administrators. Following these visits, the committees prepared individual reports describing their impressions of the visited institutions. The three committee chairs, ably assisted by the national research organization staffs and representatives of the Steering Group of the evaluation of clinical research, subsequently communicated by telephone, email and at a meeting in Stockholm to plan the writing of this Report.

Although the aggregate visiting group (henceforth 'The Panel') noted predictable prominent differences in the research productivity of different centers – the large urban institutions having far more output than the small ones in more remote regions – and some system variation in the approaches to clinical and research funding, the most striking observation was an overriding similarity in the historical time-line of publication output and in the perceptions of strengths and weaknesses in the centers with respect to clinical research. As a result of this information, the Panel generated the following conclusions.

Conclusion 1. The bibliometric analysis reveals a trend of declining pre-eminence in Finnish and Swedish research output. Although the countries have achieved premier international rankings in biomedical research publication number and impact, consistent with the existence of vibrant forward-looking flagship research programs witnessed by the visitors, recent data reveals declines, as other countries output and impact increase. Such analyses have limitations, but the changes resonate with problems identified by the Panel

Conclusion 2. The most immediate concern was a widespread perception that circumstances have eroded the appeal and sustainability of a clinical research career. The malaise affects all parts of the career cycle. First, medical students and postdoctoral trainees attempting to establish clinical research credentials, usually legitimized with a PhD degree, languish far too long in training incubation and are

often approaching or even exceeding 40 years of age before gaining eligibility for independent service and research. Second, junior clinical research faculty do not have an orderly predictable career development pathway. They languish in jury-rigged positions with uncertain financial support. Third, in Sweden, junior faculty cannot risk leaving the positions they have to acquire research experience elsewhere, including abroad, because of a statutory regime that affords tenure to clinical positions, simply based on time in a position. This situation has the doubly discouraging fallout: it inhibits research training mobility essential for ensuring familiarity with cutting-edge science and conveys that research activity not only conveys no career advantages but also actually can be disadvantageous. Senior faculty chafe at the notion that clinical leadership positions, previously reserved for persons with research track records, frequently are occupied by individuals having no such experience. They see that this situation marginalizes them in important institutional decisions and contributes to the service burdens that distract junior faculty from their research work.

Conclusion 3. A combination of inadequate national funding for the academic health centers and a governance system that pits academic researchers in academic health centers against hospital administrators charged with providing community health services in the allocation of such funding is a source of resentment and frustration by the research community. It arguably contributes to the perception that research work does not advance and potentially disadvantages a career in medicine. It results in funding incentives seducing potential clinical investigators away from research careers and contributes to the time distractions those researchers in training must suffer to provide clinical services. Funding constraints exacerbated by bureaucratic entanglements are also perceived as depriving clinical researchers of core facilities, research support infrastructure, management assistance and other ancillary modalities that facilitate world-class clinical research productivity.

Conclusion 4. Efforts in the centers to commercialize academic intellectual property, a process that is required to deliver innovation to patient care, are ongoing in all of the centers. However, these efforts vary considerably in scale and scope.

On the basis of these conclusions, the Panel made the following recommendations:
Recommendation 1: Radical Overhaul of Clinical Research Career Life Cycle. Suggestions concerning this recommendation include: shortening the duration of clinical and research training, enfranchisement of postdoctoral clinical research junior faculty with well-mentored tenure track positions to afford adequate time for research work and the opportunity to demonstrate excellence by competing for independent research funds; system adjustments to accommodate mobility in research training; and greater involvement of researchers in leadership decision-making in the centers.

Recommendation 2: Increase and Stabilize Funding for Clinical Research. In addition to raising the absolute amount of money dedicated to clinical research, the Panel believes that it is important to diversify the sources of funding in order to minimize the potential ossification that exist in single-payer schemes. With rare exceptions, allocation of such funds should be based on research track record of senior faculty and research potential of junior faculty and trainees.

Recommendation 3: Confront head on the tension between clinical research and clinical service activities in the centers by admitting its existence and revising governance structures to enable research to have a more prominent say in leadership of the centers. These negotiations should strive to minimize bureaucratic impediments and promote the establishment and sustainability of research performance, management and support infrastructure.

Recommendation 4: Insofar as possible, capitalize on the momentum initiated by this pan-national and international review to encourage the centers to share or pool resources and expertise with respect to core research facilities and intellectual property commercialization efforts.

Recommendation 5: Establish a system for benchmarking parameters that measure research productivity as a tool to document the effects of these recommendations and making adjustments to them in the future.

The Panel hopes that these recommendations will enable the clinical research programs in Finland and Sweden to reverse the present decline in motivation and productivity, mitigate the concerns articulated at the centers and maintain these centers in their rightful premier position in international clinical research competition that will improve the health of the population and promote economic prosperity.

Background and Purpose

The Research Council for Health of the Academy of Finland and the Scientific Council for Medicine of the Swedish Research Council initiated a joint effort to evaluate the quality and status of clinical medical research in both countries in February 2008. In 2007, the Swedish Minister of Education and Research had commissioned Professor Olle Stendahl to conduct an inquiry of clinical research in Sweden, and as part of this task, an international evaluation of clinical research in Sweden was asked for.

It is apparent that many of the obstacles affecting the quality of clinical research are not specific for Sweden or Finland. Recruitment of clinical investigators, infrastructure resources, and collaboration between the university and the health service are challenges common to most countries. However, different solutions may have been found to these problems, and it was therefore considered valuable to conduct this evaluation and follow possible recommendations presented by the evaluation panel in a synergistic way in Sweden and Finland.

A Steering Group was appointed, and the evaluation process was launched in spring 2008. The evaluation was decided to be conducted during 2008 with a final report in March 2009. The international evaluation was organized, managed and financed by the Academy of Finland and the Special Inquiry Commission of Clinical Research in Sweden in collaboration with the Swedish Research Council.

An international panel of experts was appointed to evaluate background material provided by the institutions to be evaluated, and to make site visits to the different universities, and meetings were also held with predecessors of university hospitals. The appointed 15-member expert panel was divided into three sub-panels and the site visits took place in autumn 2008.

Definition of the Field to Be Evaluated

The field to be evaluated consisted of clinical medical research. This could include research from other areas of medical sciences ONLY if they are vitally linked to clinical research, and the research in question uses the university hospital or the university hospital resources. The evaluation was carried out at faculty level. Individual researchers or research groups were not evaluated.

The basic unit to be evaluated was the Faculty of Medicine or corresponding institution. The units evaluated were:

Sweden:
- Faculty of Medicine in Lund University
- Faculty of Health Sciences in Linköping University
- The Sahlgrenska Academy in the University of Gothenburg
- Karolinska Institute, Stockholm
- Faculty of Medicine in Uppsala University
- Faculty of Medicine in Umeå University

Finland:
- Faculty of Medicine in the University of Kuopio
- Faculty of Medicine om the University of Oulu
- Faculty of Medicine in the University of Helsinki
- Faculty of Medicine in the University of Tampere
- Faculty of Medicine in the University of Turku

and the corresponding university/institute hospital at each site:

Sweden:
- University Hospital in Lund, University Hospital in Malmö
- University Hospital in Linköping
- Sahlgrenska University Hospital in Gothenburg
- Karolinska University Hospital in Stockholm
- Akademiska University Hospital in Uppsala
- Norrlands **University Hospital in Umeå**

Finland:
- Kuopio University Hospital
- Oulu University Hospital
- Helsinki University Central Hospital
- Tampere University Hospital
- Turku University Hospital

Objectives of the Evaluation and Evaluation Criteria

The Steering Group stated that the results of the evaluation of clinical research can be used as a tool in decision-making by the funding agencies, and in developing research structure and improving the quality of clinical research in both countries. It was also considered a new possibility to improve the public support to clinical research in the future.

Performing the evaluation at the same time with shared aims and background material was an excellent opportunity to compare and develop clinical research in Finland and Sweden.

Evaluation objectives were:

1. Evaluation of the overall quality of clinical research
2. Recognition of strong and weak research areas
3. Evaluation of the differences between disciplines
4. Comparison of the differences in clinical research in Finland and Sweden
5. Assessment of the adequacy and allocation processes of funding
6. Recognition of the platforms where basic and epidemiological research are efficiently linked to clinical research
7. Assessment of future prospects of clinical research in Finland and Sweden
8. Assessment of the quality and volume as well as problems in career development of young physician-scientists.

The overall evaluation criteria were:

1. Quality and status of research
2. Clinical research strategy
3. Characteristics of academic staff
4. How to improve linkage between clinical research and health-care system
5. How to improve career development of young medical doctors aiming at a research career
6. Recommendations for developing clinical research in the future
7. Recommendations for organizations that fund and steer clinical research
8. How to improve industrial collaboration.

Detailed description of evaluation criteria can be found in the document 'Terms of Reference' (Appendix A).

Execution of the Evaluation

The evaluation of clinical research in Sweden and Finland was initiated in February 2008 by the Research Council for Health of the Academy of Finland and the Scientific Council for Medicine of the Swedish Research Council. In February 2008, the Research Councils appointed a four-member Steering Group. Members of the Steering Group were:

- *Kalervo Väänänen*, Professor, Chair of the Research Council for Health, Academy of Finland, Chair of the Steering Group
- *Kari Raivio*, Chancellor
- *Olle Stendahl*, Professor, Special Inquiry Commission of Clinical Research in Sweden
- *Håkan Billig*, Professor, Secretary General of Medicine, Swedish Research Council

The Evaluation Team consisted of:

- *Riikka Pellinen*, Coordinator (Senior Researcher, University of Kuopio)
- *Anette Gröjer*, Coordinator (Head of Evaluation Unit, Swedish Research Council)
- *Sara Illman*, Science Adviser (Health Research Unit, Academy of Finland)
- *Mikael Fogelholm*, Director (Health Research Unit, Academy of Finland)
- *Pernilla Arrland*, Secretary (Special Inquiry Commission of Clinical Research in Sweden)

The duties of the coordinators were to assemble the panels, formulate the questionnaires, compile the evaluation documents collected from the field as well as to assist the Panel during the site visits and report editing. In addition, the coordinators were responsible for communication related to the evaluation process. The administrative support and assistance for the evaluation Steering Group and Coordinator as well as the practical details of the seminars and site visits were organised by the Academy of Finland and the Swedish Research Council.

The overall evaluation process took for a little more than one year. The implementation of the recommendations will continue beyond this time period. The flowchart of the evaluation process is shown in Figure 1.

The Steering Group had altogether three meetings before the site visits. At these meetings the objectives of the evaluation were defined and the guidelines for the evaluation background material were set. These guidelines are presented in Appendix C. In addition to the background material produced by the institutions, a bibliographic analysis was made for the panels use. The bibliographic report was produced by Staffan Karlsson at the Swedish Research Council. This report is attached as Appendix D to this report. The institutions were given the opportunity to submit additional material for the panel in form of annual report (2007), clinical research strategy and other relevant material.

Steering Group members made suggestions for experts to be invited as panel members, and the coordinator sent out inquiries based on these suggestions. It was

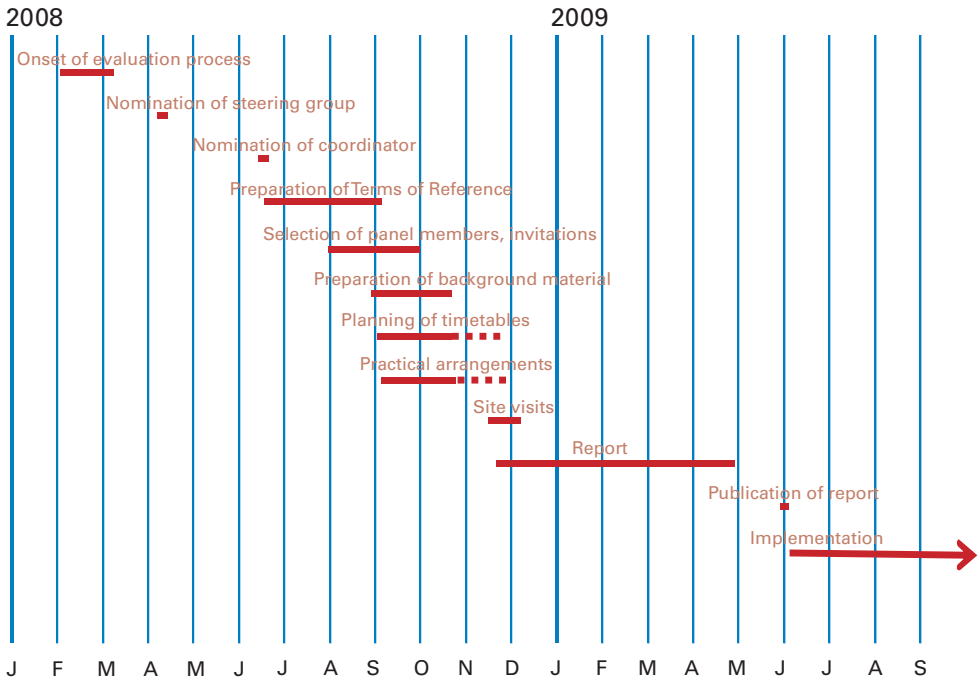

Figure 1. Flowchart of the evaluation process.

decided that the 15-member panel should represent as many different disciplines as possible, and panel members should come from different countries with the focus on having at least one member in each sub-panel from the Nordic countries. These criteria were all achieved. Disciplines represented on the panel included anaesthetics, audiology, cardiology, clinical biology, clinical genetics, dermatology, endocrinology, female reproductive physiology, haematology, immunology, internal medicine, neurobiology, nursing science, pediatrics, respiratory medicine, vaccine and immunotherapy, and psychiatry. Former evaluation and science policy activities were also considered when possible panellists were surveyed.

The site visits took place in November–December 2008 as described in Figure 2. On the day of the arrival, at least one of the Steering Group members met the panel and together with the coordinators gave further information about the evaluation process. Panellists stayed in each institution for one day, and travelled to the next location in the evening. The last day of the site visit was always reserved for panel meeting either at the Academy of Finland, or in the Swedish Research Council premises.

To obtain information on similarities and differences in the two countries, it was considered that each sub-panel should visit faculties in both Sweden and Finland. The site visits were organized accordingly, but resulted in an extensive amount of travelling; especially demanding for panel 1. Panels 1 and 3 visited four universities, whereas Panel 2 visited the three largest universities. On the other hand, there were differences in the size and age of the universities assigned to sub-panels 1 and 3, and this somewhat complicated the writing of the evaluation report. It must be noted that because the evaluation report has been written by altogether 15 experts, divided in three, the report will contain formal differences.

	Sun	Mon	Tue	Wed	Thu	Fri
Panel 1	9.11.08 Lund Arrival of panelists	10.11.08 Lund Site visit at the faculty	11.11.08 Linköping Site visit at the faculty	12.11.08 Kuopio Site visit at the faculty	13.11.08 Oulu Site visit at the faculty	14.11.08 Helsinki Meeting Departure
Panel 2	16.11.08 Helsinki Arrival of panelists	17.11.08 Helsinki Site visit at the faculty	18.11.08 Göteborg Site visit at the faculty	19.11.08 Karolinska Site visit at the faculty	20.11.08 Stockholm Meeting Departure	21.11.08
Panel 3	7.12.08 Tampere Arrival of panelists	8.12.08 Tampere Site visit at the faculty	9.12.08 Turku Site visit at the faculty	10.12.08 Uppsala Site visit at the faculty	11.12.08 Umeå Site visit at the faculty	12.12.08 Stockholm Meeting Departure

Figure 2. Timetable for the site visits.

The overall day schedule was planned by the evaluation team and sent to faculties in order to have a similar set-up of interviews for all three panels. The outline of the day schedule on site visits is shown in Table 1.

Panel members attended all the introductions and discussions except in cases where conflict of interest emerged (Professors Agartz and Liu withdraw from the site visit and evaluation of the Karolinska Institute in Sweden). At least one of the coordinators was always present on the site visits. Additionally, the contact persons nominated by institutions attended, and they were asked to withdraw during the discussions between panel members and researchers.

Table 1. Outline of the day schedule at each faculty.

9.00	Arrival	
	Introduction of clinical research	Deans, department heads, hospital representatives, other executives
	Discussion	Deans, department heads, hospital representatives, other executives
	Discussion with technology transfer officials	Technology transfer officials (licensing, patenting, technology marketing)
	Discussion with clinical researchers	10 clinical researchers chosen by the faculty
12.00	Lunch break	
	Discussion with young researchers	10 researchers chosen by the faculty (PhD students, MDs, and post doctoral fellows)
	Discussion with faculty representatives	Deans, department heads, hospital representatives, other executives
15.00	Meeting	
	Departure	

Evaluation of Clinical Research in Sweden and Finland

Chair's Preface

Sweden and Finland have a world leading position in supporting research. Both countries also have a long history of periodic critical self-evaluation. In line with this tradition, the Swedish Research Council and the Academy of Finland decided to evaluate the clinical medical research in their countries.

The members of the international evaluation panels were impressed by the quality of the past achievements, by the extensive and frank self-evaluation reports, and by the willingness of all Finnish and Swedish investigators and institutions to discuss their strengths and weaknesses. Moreover, the panel members had the privilege to meet and discuss with dedicated world-class professionals so that they enjoyed and were enlightened by these contacts. We hope that our analysis and suggestions may guide the funding organizations and the policy decision-makers as to support scientists, clinical research communities and their institutions as to maintain or strengthen their premier position in clinical research. This would create a multiple win-win situation for the health of their population, the optimal use of health care investments and promote economic prosperity, with additional benefits for many other countries around the world.

The panel members and all co-chairs thank the Swedish Research Council and the Academy of Finland for confiding such an important mission to them.

Roger Bouillon

Introduction

All panel members were impressed by the quality of the extensive data generated and provided by all centers visited. This very informative data greatly facilitated the preparation of the meeting. The panel members were also impressed by the honest and critical self-analysis of the centers' past and present situation and their prospects and plans for the future. Moreover, the openness of all (from university and hospital leaders to senior and junior scientists) to reveal and discuss the potential weaknesses and threats was remarkable. Therefore, the panel members sincerely wish to thank all universities and centres and all who invested efforts and time for the preparation of panel visits for their constructive contributions and warm welcome. Our special thanks go to all who took the time, during the day of the site visit, for an open and frank discussion with the panel members.

The extensive bibliometric state-of-the-art analysis of the medical research efforts of both Sweden and Finland, using a large number of benchmark countries and regions also greatly contributed to the preparation of the site visits and the present report.

Past performance and bibliometric analysis of medical publications from Swedish and Finnish universities

The evaluation panel is unanimously convinced that clinical research in Sweden and Finland has achieved and rightly deserves an excellent international reputation. This conclusion is based on personal impressions of the evaluators, the discussions between the panel members and junior and senior staff members of all universities, and the documents describing the publications and flagship clinical activities presented during the evaluation process of all universities.

The extensive bibliometric analysis of biomedical and clinical research in both countries, as performed by S. Karlsson and A. Jonsson (Swedish Research Council, Dept. Research policy Analysis, Appendix D.) according to state-of-the-art methodology used in this field (Glänzel et al. 2008, Hill et al. 2007), confirms this impression and allows an in-depth evaluation of the research activities of both countries and all their universities with a medical faculty. Despite some intrinsic limitations of bibliometric analyses as a benchmark of research effectiveness (Young et al. 2008), the data nevertheless clearly demonstrate that both countries have previously outperformed many other European countries in biomedical research productivity in general and in clinical research output in particular.

Sweden contributes 1.5 and 1.6% of all worldwide ISI-recorded publications (2004–2006) in the field of biomedicine (Appendix D. Bibliometric analysis of medical publications from Finland and Sweden, Section 3.1) and clinical medicine, respectively. Similarly, Finland generates 0.7% of all world publications in both fields. This is an impressive achievement in view of the population size of both countries. When recalculated on a per capita basis for both sub-disciplines together (labeled as medical publications), Sweden is, together with Switzerland, the absolute number one in medical publications per year per million inhabitants (Figure 3), whereas Finland ranks number 6; both countries are thus performing extremely well with regard to the number of medical publications and do so substantially better than the UK, USA and the whole EU15.

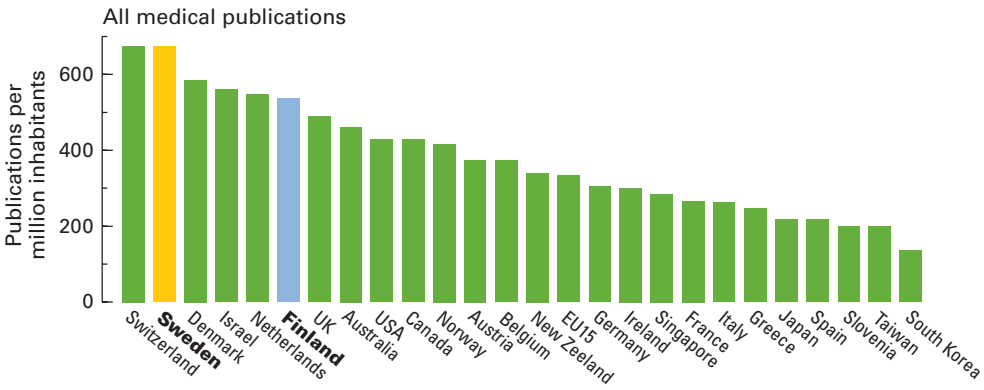

Figure 3. Per capita production of medical publications; publications per year and million inhabitants. Population statistics from OECD.

Clinical medicine (as defined in the report and in most biomedical bibliometric analyses worldwide as based on ISI sub-classification) generates many more publications than biomedical research, as well worldwide as in Sweden and Finland (about 2/3 of all medical publications are labeled 'clinical' versus 1/3 biomedical research), but a similar ratio is found for most European countries. Although these two sub-classifications have many limitations, they nevertheless clearly demonstrate that publications generated by clinical research disciplines are a major part of the overall (bio)medical research effort.

While simple publication numbers do not in themselves document research quality, citation analysis provides an estimate of international visibility to other scientists in a particular field and therefore a reasonable reflection of research quality as defined by peers over time. Many biases confound such analyses, especially when different sub-disciplines with diverse research and publication strategies are compared, or when such analysis attempts to compare individuals or small groups of scientists. For comparison between countries, however, bibliometric analysis using publication and citation number, with appropriate corrections for fields, is the only widely applicable method to generate quantitative long-term data. The only well-established inherent limitation is the citation (and possibly publication) bias in favor of native English-speaking countries and especially a bias of US authors preferentially citing US manuscripts (Glänzel and Schubert 2005, Winkmann et al. 2002, EMRC White Paper 2008).

In a worldwide comparison, Sweden and Finland rank numbers 8 and 18, respectively, in citation analysis of 'biomedicine', and they fare even better, ranking 6th and 7th in 'clinical medicine' citations. In clinical medicine, both Sweden and Finland are thus in the top 5 group of European countries and above the average world citation rate for this field. An analysis of the top 10% most cited articles confirms this excellent record, as Sweden and Finland again reside in the top 5 of European countries for clinical medicine (Appendix D. Bibliometric analysis of medical publications from Finland and Sweden, Figure 6.) with a similar trend for the top 1% of the most cited clinical publications.

For citations to biomedicine publications, Sweden outperforms Finland as Sweden is situated in the top 5 European countries, Finland being slightly below the EU15 average. (P.S. citations were calculated over a 3-year period following publications in ISI recorded from 2004 to 2006).

Although the Panel was not in a position to make detailed analyses of the overall research productivity of the individual centers and only was directly exposed to some of the centers' most successful operations, the bibliometric data provided to the Panel and a perusal of publications from the centers imply that on balance the research success appears amply supported. Nevertheless, some of the centers alluded to weak research activities, but the Panel did not address this issue.

A separate analysis of publications and citations generated by the individual Swedish and Finnish universities reveals, as in most other (European) countries, that universities and university hospitals generate the large majority of clinical medicine output. In both countries it is obvious that the absolute publication output is very unequal between universities. The University of Helsinki (HU) generates nearly half of the combined Finnish university output in both biomedicine and clinical medicine,

with the other four universities producing the other half. In Sweden, Karolinska Institute (KI) generates about 1/3 of all Swedish publications in either biomedicine or clinical medicine, followed by three middle-sized 'output generators' (Lund, Gothenburg and Uppsala) and two universities generating a low number of publications (less than 1/4 of KI, and similar in size to the non-Helsinki Finnish universities). This already demonstrates that four Finnish (Kuopio, Oulu, Tampere, Turku) and two Swedish universities (Linköping, Umeå) have a low absolute publication output in comparison with the two major and three 'medium-sized' Scandinavian universities.

The quality of the publications, as estimated from their citation volume (mean citation rate), indicates that the two largest universities (Karolinska Institute and Helsinki) generate a high- quality output, exceeding the world average and the rate of the other universities of their country. Three small Finnish (Oulu, Tampere, Turku) and one small Swedish university (Linköping) generate a mean citation rate just below average. The overall world visibility (as revealed by mean citation rate) is thus reasonably good in the medical field for small Finnish and Swedish universities and excellent for the largest universities generating world class publications. An independent, yet unpublished, bibliometric analysis of a very large number of European universities compared to a number of US universities confirm the excellent position of the major Swedish and Finnish universities in the field of clinical medicine and life sciences with Karolinska Institute and University of Helsinki among the best performing European universities (LERU analysis by Leiden and Leuven, unpublished). However, all European countries, even the top five performers, are lagging far behind the US with regard to overall citation number and even more with regard to top 10 and top 1% of the most cited articles in ISI records (Hill et al. 2007, EMRC White paper 2008). This also applies to bibliometric ranking of individual universities as the top 20 European universities (including KI and HU) are lagging behind their best US counterparts.

The bibliometric analysis also provides information about the relative strength of the two countries and the individual universities in specific areas (defined by ISI criteria). Such data would need a more in-depth analysis to really identify the relative strength and weaknesses in different scientific areas, and particularly requires insight in the structure of the groups that generate this output as well as their potential for the future. Therefore, the Panel preferred not to comment on this area-specific strength analysis. When looking at the area/discipline-specific performance of the individual universities, however, it is quite clear that the two major universities (KI and HU) and a few medium-sized Swedish universities (especially Gothenburg and Lund) have a wide range of disciplines that are bibliometrically outperforming the world average. The smaller universities, however, exhibit a more modest performance, presumably due to a lower critical mass of resources and personnel.

The bibliometric analysis, however, also reveals a disturbing trend relevant to the future of clinical (and perhaps all biomedical) research in Sweden. The relative position of Swedish biomedical, and to a greater extent, clinical research output (measured as the annual publication rate) has deteriorated over the last 15 years in comparison to the absolute output that is growing steadily in most other countries. This downward trend is also detectable in the Finnish publication output over the last

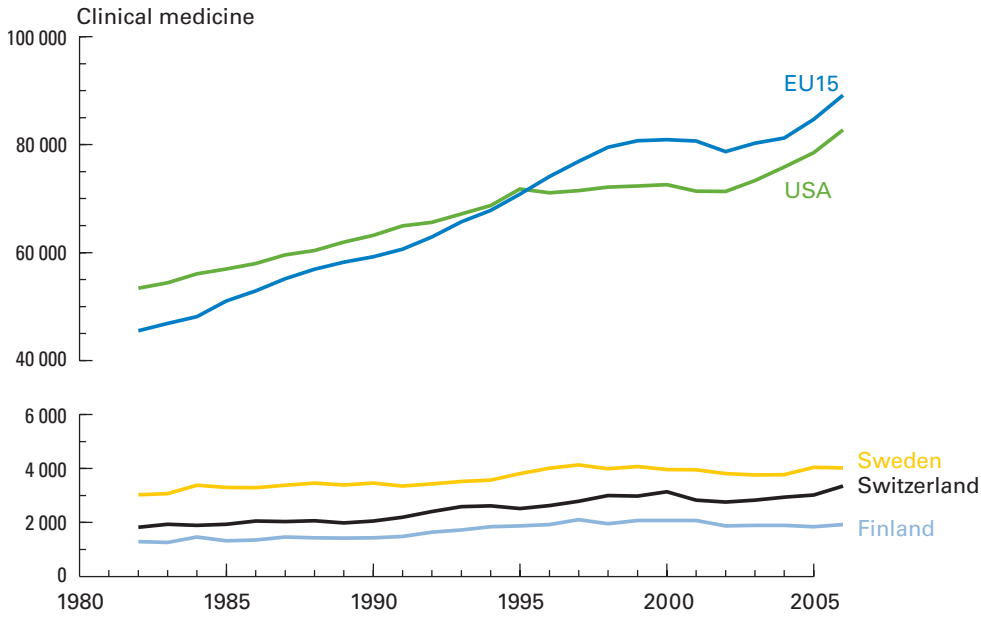

Figure 4. Publication rates of selected countries and areas in 1980–2005.

ten years (Figure 4.). Clearly many countries that performed poorly in the past in the medical fields have engaged in catch-up productivity growth. However, the relative decline in Swedish and slightly less severe decline in Finland are worrisome as it is also apparent in comparison with the global EU15 output and most other European countries. A similar pattern can be observed when looking at mean citation rate in both Sweden and Finland over the last 5–10 years. This interpretation of trend evolution was also clearly and repeatedly cited during the many discussions with university leaders and senior as well as junior scientists during their panel visits.

Overall conclusion concerning the bibliometric analysis

1. Sweden and Finland are world leaders with regard to the number of publications in the field of medicine. The crude and field corrected analysis of citations to Swedish and Finnish medical publications confirms the excellent visibility and quality of these publications as Swedish and Finnish manuscripts in clinical medicine are highly cited (analyzed globally or calculated as top 10 and 1% most cited medical publications) bringing both countries in the top five of European countries and thus among the very best in the whole world. The overall perception is also that Sweden has such output and visibility for both medical and biomedical publications. Finnish medical publications also achieve these results, with a slightly lower quality estimation.
2. The publication data varies considerably between different Swedish and Finnish universities with the two major universities (KI and HU) generating most of the output. They also are able to play a leading role in many specific clinical or biomedical research areas as revealed by domain-specific citation analysis. All other Finnish universities and at least two smaller Swedish universities generated a much lower number of publications and are practically unable to play an above-world average role in specific areas.

3. The quality of medical research generated by most Swedish and Finnish universities is above world average, and some larger universities have generated a top, world-class performance, especially KI, HU and also Gothenburg and Lund. This visibility, measured by mean citation rate, also reaches world-average levels in smaller universities, so that no truly well below-average performing universities were identified.
4. A concern is the relative decline of Sweden and Finland and even the best universities with regard to publication and citation number over the last 5–10 years. This bibliometric observation was confirmed by many university leaders and scientists and identifies a potential threat for the future of medical and clinical research of both countries and their leading universities.

In summary: the panels concluded that Sweden and Finland and their medical centers should be congratulated for their impressive research accomplishments. In all the centers, imaginative and entrepreneurial senior investigators have created flagship programs and research- and research education-facilitating activities. These programs include interdepartmental, interdisciplinary research and development activities as well as core facilities for basic and clinical research. The investigators have optimized the use of resources by identifying research foci. These efforts have been rewarded by the awarding of grants based on competitive review by external funding agencies. In addition, various rating benchmarks have ranked the programs highly. However, several benchmarks indicate that the relative strength of the medical research output of Sweden and Finland may be losing momentum, and it is highly likely that this threat is due to a combination of events that were identified in the SWOT analysis by individual centers and by the panel members during their preparative work and site visits.

Evaluation of concerns and problems for clinical research in Sweden and Finland 2008

Unsurprisingly, certain differences between Sweden and Finland in academic health care and clinical research activities were apparent to the panel members during their short visits (1 day/center).

These differences include:

- Differences in qualitative and quantitative output (see bibliometric analysis)
- Differences in size of medical centers with respect to physical plants, students and, to a greater extent in faculty number, acquisition of national and international funding, and publication & citation records)
- Differences in history and traditions
- Differences in funding systems
- Differences in health care systems
- Differences in intellectual property ownership and commercialization strategies

Nevertheless, the panel members were struck by the similarities in both countries with respect to the SWOT analysis provided by the different centers, and by their impressions obtained during the site visits. In fact, most of the problems and threats identified are very familiar to the panel members from experience in their home

countries, and have been identified as major obstacles and problems in Europe and even worldwide (EMRC Forward look 2009, EMRC White Paper 2008). Therefore, the panel members including the three co-chairs considered that it would be more productive to emphasize the common strengths and problems in order to identify the possible strategies for future optimization of medical research in both countries.

Despite the difference in history, size and regional location of the six Swedish and five Finnish universities with a medical faculty, the SWOT analysis performed by the individual universities and the overall impression by the three different panels revealed a large number of similar strengths and weaknesses as well as opportunities and threats (Table 2), as identified by different medical faculties. Strikingly, the SWOT analysis shows that most institutions recognize good collaboration between the university hospital and academic departments as strength, while during the site visits the panel members got an impression that the situation in most universities was the opposite. Therefore collaboration issue is discussed later in this report in depth under "Panel recommendations".

Table 2. SWOT analysis of medical research in Sweden and Finland as identified by the 11 centers visited.

Strengths	**Weaknesses**
Close / good collaboration with the region / university hospital Translational research Access to large clinical data and patient population Infrastructure and core facilities Good communication between experimental and clinical researchers	Limited time for research due to heavy load of clinical work Low / decreasing funding (incl. EVO and ALF) Too few research areas with critical mass Recruitment problems Difficulty to recruit medical students to PhD programmes
Opportunities	**Threats**
Career program / support system Good national/international cooperation New recruitment tools or possibilities Patient material Increasing translational research	Loss of young and experienced researchers Increasing clinical demand and economical restrains in the health care system Changes in EVO funding Negative attitude / lack of interest to research among MDs Decreasing funding

Concerns and problems

The different panels identified a number of strengths and weaknesses that are more or less typical of each individual university as reported in the report per institute.

The common themes for nearly all institutions are:

1 Career of clinical researchers/scientists

Finland and especially Sweden are known for having a relatively large population of MDs willing and able to combine their clinical training with research education institutionally recognized by the conferral of a PhD degree. Few countries around the world can compete with the quantity and quality of such combined training.

The timing and ordering of research and medical training varies in the two countries. But whatever the specific arrangements in place for completing the joint training obligations, excellent as they are, a pervasive problem is the extended duration of the educational process. As revealed during interviews of the three panels with senior and junior scientists, the time elapsed to obtain a combined MD–PhD degree is seen as a major handicap; the trainees frequently do not complete the process until they are > 40 years of age, and in some cases they are 45 years old upon training completion. This overlong gauntlet can be followed by a poorly defined postdoctoral fellowship. Indeed, in the centers visited, young clinical investigators appear to have to cope with variably funded positions cobbled together by different mechanisms. As a result, postdoctoral researchers seem to orbit in limbo for many years, hoping that a sufficient research accomplishment portfolio will mesh with a professorial position opening up. In this respect, the Scandinavian Centers subject future potential faculty to an even more uncertain situation than exists as serial postdoctoral positions that characterize American academic science.

The financial rewards for a combined MD-PhD and postdoctoral fellowship are frequently inferior in comparison to MDs undertaking purely clinical training and moving into a clinical appointment track. Not only the absence of premiums, but even lower financial remuneration and lower or delayed professional status were identified as additional obstacles for MDs willing and able to choose a (clinical) research career. In Finland, no salary premium comes with specialization and subspecialisation, whereas in Sweden, there is market competition for specialists. In both cases, the systems contribute to the perception that research work does not help but rather potentially detracts from remuneration prospects. Both senior and junior investigators in the centers alluded to the new presence of clinicians with no research distinction occupying clinical leadership positions and to the fact that research accomplishments bring little or no financial advantages. In fact, the combined MD-PhD career track may cause a lifelong disadvantage, because it delays the clinical

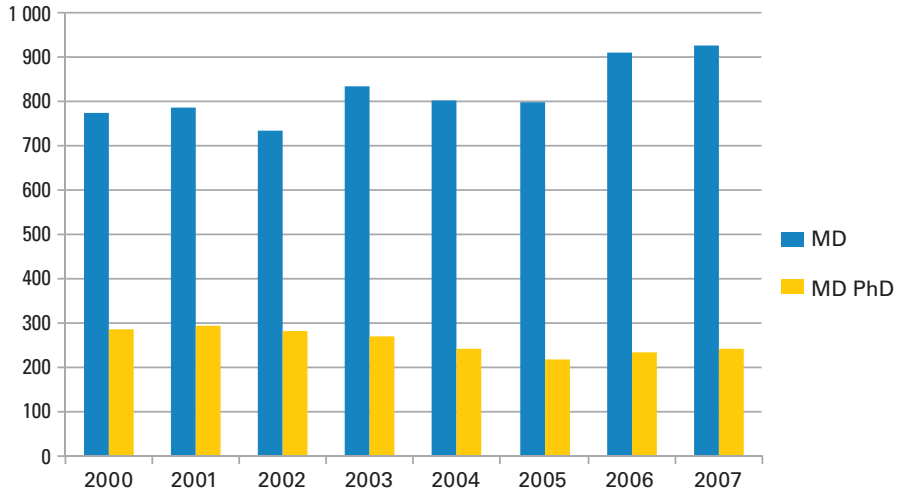

Figure 5. Graduated MDs and MD PhDs in Sweden 2000–2007. (The number of MD PhD degrees during 2005–2007 excludes degrees taken in Sahlgrenska Academy, Göteborg, data not available).

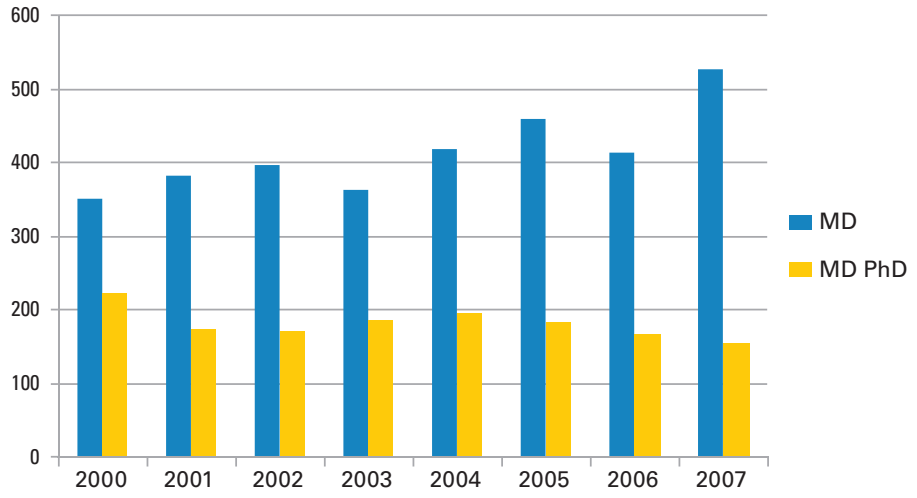

Figure 6. Graduated MDs (LL) and MD PhDs (LT) in Finland 2000–2007.

career path and its much better salaries. Nevertheless, many young scientists have been willing to continue such a difficult career path simply due to scientific excitement and the excellent science environment, especially as experienced in the major universities.

Finally, the panels were informed by university leaders as well as by senior and junior staff that the difficult career path of clinical scientists no longer receives, as in the recent past, the esteem, prestige and intellectual and moral support. Simultaneous changes in societal attitudes expect from these young (and not so young!) clinical scientists more time for family obligations/commitments and recreation, creating a situation with few incentives and many disincentives for a clinical research career. This state of affairs coincides with a time in which private clinical practice is actively recruiting the best talent. In Finland, resentment was articulated concerning what seems to be a clever market-based solution to a primary physician shortage. Private companies match young physicians with underserved hospitals, managing not only to profit but to provide better salaries and call schedules to their clients than afforded by the government system (although, ironically, all the funding arises from the government!). The major concern about this arrangement appears to be that it seduces young physicians away from academic (research) tracks. The Panel was told that in contrast to some other locations in the world, having an academic position does not afford cache value to a physician. Swedish and Finnish patients do not seek out 'prominent' physicians, and it is not a cultural norm for academic physicians to advertise their value (e.g. in news media presentations).

Social status of clinical research

The Panel was repeatedly confronted by remarks about the rapidly decreasing respect, recognition or appreciation for research efforts by MD/clinicians. Apart from financial and career handicaps described above, junior and senior scientists reported to the Panel members that the hospital administration and most (with few highly appreciated exceptions) clinical heads of units/departments give priority to normal clinical care so that research time is not respected at all or paid lip service, and that

clinical and laboratory facilities and overall clinical infrastructure is insufficiently available for clinical scientists. Above all, they feel that the esteem and prestige associated with research is waning. Clinicians involved in basic or clinical research frequently feel handicapped in a purely routine clinical environment but also in highly competitive basic science units. Nevertheless their knowledge and expertise are essential for biomedical translational research and the 'sheer survival and blossoming of this endangered MD-PhD species' need more than lip service. This lack of support and encouragement hardly rewards the many extra efforts and sacrifices that research requires from usually the best and brightest.

2 Relationship between academic medicine and country/county health care system

In both Sweden and Finland a strong locally organized health care system uses a variety of health delivery centers and the university and medical faculty have access to this system for teaching and research. The hospitals are usually run and financed by the local health care system (e.g. counties in Sweden). The hospital management system is under increasing pressure to optimize health care at the lowest cost, and this stress is felt at all levels in the hospital. Therefore, nearly all Panels were confronted with sometimes even very harsh comments from academic leaders and nearly all scientists about the priority for clinical care above these teaching obligations and especially their clinical research functions.

Nearly all universities reported the need for stronger links and agreements between the hospital management leaders and academics as to restore or at least improve the academic function of the hospital system.

In smaller universities and in more remote regions the contact between both 'worlds' seemed to be somewhat better. Some universities were proud to announce novel governance structure to face the challenges between optimized health care services and academic priorities (e.g. Karolinska Institute and Stockholm county).

1. Nevertheless, the panels were struck by the remarks of many clinical scientists that:
2. Top clinical appointments were increasingly based on management skills and not on academic track records

Clinical science was increasingly subordinated to daily clinical practice with major consequences for career choices of young staff members. The struggle for sufficient research time was felt as increasingly difficult due to a combination of priority setting for clinical duties by chairs of units and departments, and by societal pressure for family and leisure activities.

3 Financial concerns

Sweden and Finland are known worldwide for investing a large percentage of GDP in R&D, including health care research. The EVO and ALF funding provided in the past for reasonable costs for academic tasks of the (university) hospital system. This system, together with direct government funding for academic staff, infrastructure and research grants created an optimal or at least fairly good mix for good clinical and biomedical research over the last 10–15 years, as can be seen from the research output analysis.

However, ALF funding did not grow with the increasing costs of the academic duties of the university hospital system, and EVO funding in Finland actually decreased with grim prospects for the near future. Other funding systems for research training and mixed clinical research positions (from junior postdoctoral staff to senior clinical scientist positions) exist in both countries but frequently demand applications to several funding systems. Most existing funding mechanisms only provide for a limited number of positions and usually only remunerate short-term appointments (a few months up to a few years). Finally, many remarks were made about the spending of 'academic' money (ALF/EVO) as the perception surfaced that money was by far

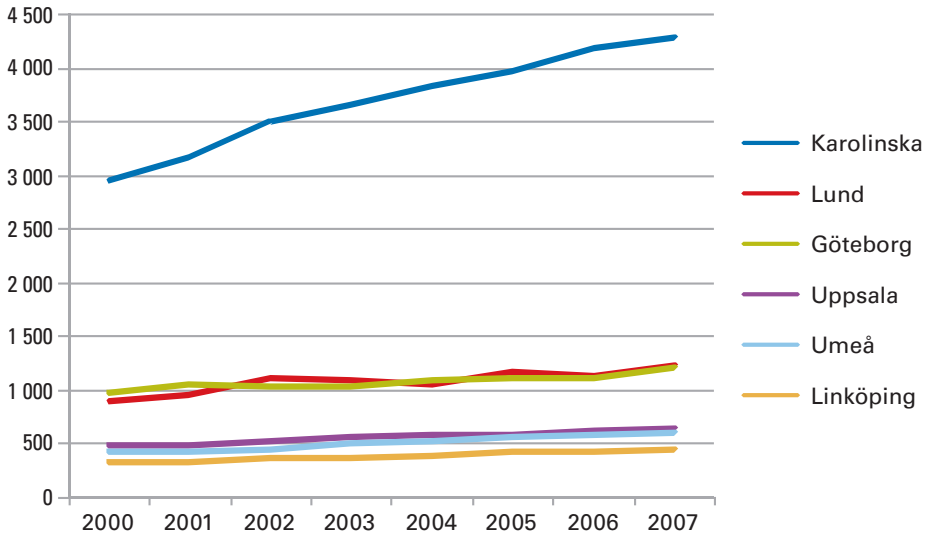

Figure 7. Total funding in Swedish Medical Institutions 2000–2007 (MSKr)

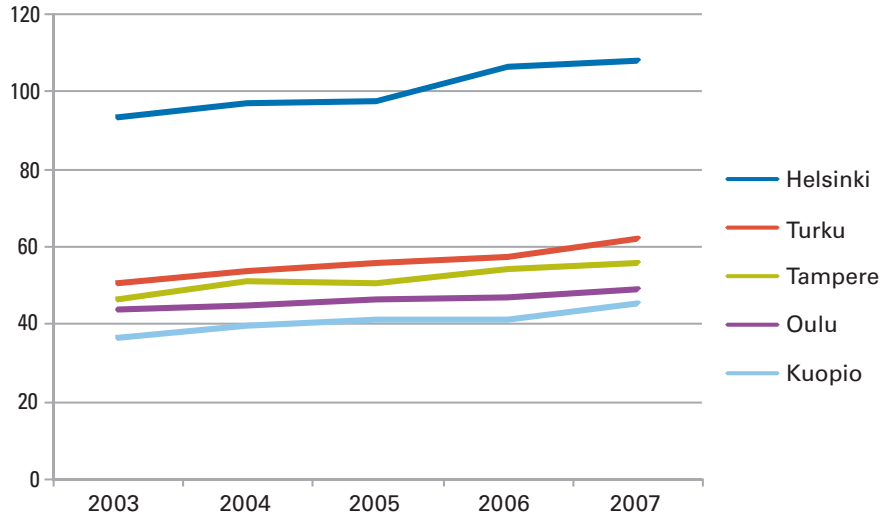

Figure 8. Total funding in Finnish Medical institutions 2003–2007 (M€).
(The funding data from Tampere excludes the School of Public Health).

not always being used for clinical research goals. The situation is further handicapped by a short-term horizon, as such 'academic money' was not assured for longer than one year. In addition, several critical remarks were made about the decision process for spending EVO/ALF money concerning the allegation that this public money is going to the hospital system without sufficient oversight by academic/science leaders. It should be considered whether at least part of this money should be allocated from national or higher level competition instead of distributing it locally.

In both countries, little or no funding is available for specific clinical research infrastructure requirements. This deficiency is serious, because clinical research projects can be very expensive due to the need for accrual of large numbers of patients, duration of follow-up and costs of non-routine research-related clinical or laboratory expenses (EMRC Forward Look 2009).

4 Infrastructure for clinical research

In nearly all centers visited by the Panels, infrastructure for clinical care, access to larger cohorts of patients (in relation to the size of the countries) willing to engage in clinical research projects, and infrastructure for basic research were cited as being major assets. By contrast, infrastructure for clinical research or access to specialised health care or clinical research assistants or access to research support modalities (e.g. imaging or laboratory testing) were lacking, incomplete or difficult to approach because of administrative or financial restrictions. Also, long term infrastructure planning for ensuring future follow-up clinical studies, was lacking.

Such core facilities are essential for competitive research, and although some interviewees commented on positive signs of attention by university leaders to this problem, more frequent allusion was made concerning impediments to affordable and efficient access to existing core facilities and to the need for creating new and better ones devoted to the needs of clinical researchers.

5 Mobility and internationalisation

Sweden and Finland are countries with small populations and significant differences in density of populations and demographic culture from South to North in each country. The balance between teaching and research activities may therefore differ considerably between individual universities of very unequal sizes within each country. Moreover, the fact that their languages are rarely spoken abroad creates a handicap for attracting young or middle-aged scientists; this obstacle is especially acute for Finland due to an even more exotic language than Swedish. As a result, international scientist recruitment is problematic. Karolinska Institute is a notable exception because of its international reputation and excellent science environment.

Of particular concern was the frequent remark that many scientists and especially clinical scientists and even most post-docs (who are typically the most mobile scientists worldwide) are unwilling or unable to go abroad to acquire international research experience. Financial restrictions, family obligations and lack of incentives were all cited as contributing factors. Of potentially greater importance is the potential of non-residence locally to compromise prospects of obtaining a permanent position. Evidently, Swedish MDs are statutorily entitled, after their specialist training, to a lifelong career path in their county hospital system, and leaving the hospital care system for research experience abroad obviates such career protection!

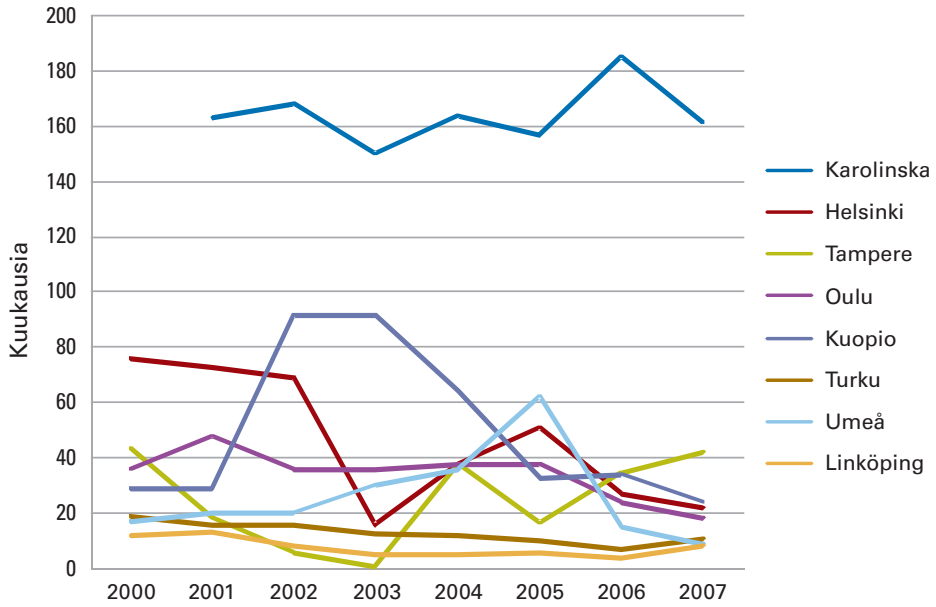

Figure 9. Researchers going abroad for training (months) from Sweden or Finland. (Data not available for Göteborg, Lund altogether 369 months during 2003–2007, and Uppsala 26 months in 2007).

In most countries the reverse situation is the rule, as experience in another institution (or country) is nearly mandatory for a major permanent academic (hospital) appointment. The Panel was also informed that paid sabbatical leave opportunities were virtually absent and not encouraged by the university or hospital leaders. Such sabbatical system may well need great flexibility and even innovative approaches for medical scientists but would certainly add to the international competitiveness of the centres.

6 Research and Intellectual Property (IP) Commercialization

All universities and centers visited are cognizant of the value of intellectual property rights (IPR) and have developed strategies to work with inventors to protect IPR and try to commercialize such inventions. The situation is quite generous for the inventors as the IPR is owned by Swedish academic inventors and by Finnish academic inventors (if inventions are based on university funding). In both counties the IPR is owned by the employers (hospital) when inventions are generated by hospital employees in Sweden or by grants to Finnish university researchers, although there are provisions for some returns to inventors

The IP transfer offices differ enormously in size and expertise as well as in achievements (e.g. number of spin-offs and income from earned royalties). In some centres the technology transfer institutes are excellent and have world-class experience. In most cases such units actually need public money, as the return from investment is still low. In view of the societal benefit such efforts are considered to be wise investments, but a subcritical mass of expertise is obvious for many young starting IP transfer offices. Strong networking activity between the centers in each country should be encouraged to share expertise in different subfields and achieve economies of scale in highly specialized areas.

Research commercialization is most relevant for early, usually basic sciences (including biomedical sciences) than for purely clinical research where IP is usually either hard to achieve or was generated in an earlier phase of basic research. Efficient collaboration with industry (strongly in need of good academic translational/clinical researchers) is, however, a major asset for academic medical centers and probably deserves greater attention. For example, clinical researchers are in an excellent position to develop novel uses for already approved products.

Panel recommendations

Since medicine became a scientific discipline it has relentlessly improved longevity and quality of life. As a result of this accomplishment, societal expectations for further improvements in health care are high. The marriage of medicine with science has also resulted in an exponential increase in health care costs, and the bills can only be paid by rationing or by sustaining economic faster economic growth than the rise in medical expenditures (Roberts 1952). Nevertheless, medical advances contribute to economic productivity, and society has valued the benefits of health care innovation sufficiently to bear the costs.

Recent and imminent research findings from biomedical, clinical and a wide variety of other disciplines create hope for major improvements in basic understanding of health and diseases. Strategies for clinical implementation of these research findings require extensive translational and clinical research that cannot be performed by basic scientists or industry without the absolutely essential participation of clinical scientists.

The societal return from such efforts is high in developed countries (Cooksey 2006, *NIH response to the Conference Report request for a plan to ensure taxpayers' interests are protected* 2001, Schacht Wendy H, 2006). Such research efforts can also benefit emerging nations with limited research efforts due to economic constraints. Research efforts represent an arena of global competition with the potential to advance the interests of the most successful competitors.

Sweden and Finland have a strong reputation in the field of clinical research and combine several ingredients that bring their countries, their academic centers and scientists into an excellent position to maintain or even improve their competitive position for medical research, if, and probably only if, a complex series of appropriate actions are taken. These actions demand strategic vision, long-term commitments including financial support and the right combination of bottom-up and top-down stimuli for an excellence-driven research competition in a supportive academic and health care system. Sweden and Finland are fortunate to combine many major assets to be successful and optimize their return-on-investment in the field of translational and clinical research. However, the congruence of findings concerning a decline in research output relative to competitors and the problems identified by the site visits imply a deterioration in research strength, further justifying the need for action.

For outside observers to dictate detailed policy to dedicated professionals of the calibre encountered in these visits would not only be presumptuous but inappropriate. It is hoped, however, that the internal examinations brought about by the prospect of the visits encouraged the center administrations and faculties to

engage in renewed efforts to devise new approaches, based on their intimate knowledge of the practical, political and cultural elements of their situations. The following recommendations should therefore be construed merely as ideas for consideration raised by observers with perspectives from different contexts. The recommendations are based on the charge in the 'Terms of Reference' in the Swedish Government Official Reports (Världsklass! *Åtgärdsplan för den kliniska forskningen* 2008), for guaranteeing that "new knowledge rapidly reaches the health service and that important clinical problems are brought back into research." Ideally, the research should address major unmet needs: such research can be defined as "high-risk, high reward" research (*Advancing Research in Science and Engineering* 2008). This type of research requires sufficient financial stability to permit investigators to take on longer-term projects.

As in all scientific disciplines, successful outcome depends on the right combination of able scientists given incentives to pursue novel ideas under optimal circumstances (infrastructure, funding and collaborators). This dependence was clearly and concisely described by Ernst H. Starling, when he addressed the British Research Council in 1924:

> *"Find the best of men, give them what equipment you can afford, and leave them alone"*

We, of course, would add, 'the best of women' as well! Clinical research is in this sense not different from other sciences but requires different skills (combined clinical and research and sometimes managerial talents) and a special environment (medical and basic biomedical as well as interdisciplinary research teams, and flexible and cooperative health care system), and above all also well-informed and collaborative research subjects. Therefore, clinical research questions and studies impose many complex ethical rules and restrictions.

Based on the very uniform interview experiences and the analysis of all available data the Panel members and co-chairs make the following recommendations, sub-classified as three major challenges embellished by some subsidiary charges.

Major recommendations

1 RECOMMENDATION ONE: Radical reengineering of research careers for health care professionals.

The career *pathway for excellent medical students, through research training to junior faculty positions and mature career clinical research positions should be substantially improved. In view of the complexity and wide variety of problems identified, a drastic reorganisation of the whole career path is necessary, taking into account the following dimensions:*

1.1 Consider pathways to shorten the time from completion of medical training to research independence.

A. Integrate research training, either within MD or specialist training programs, so that completion of training takes place at or before the trainee reaches the age of

35. Examples of systems from other countries may be useful in designing this strategy. Some of these have combined MD-PhD or combined clinical specialist-PhD training programs featuring reciprocal compensation. This approach can reduce the training requirements traditionally needed for either clinical specialist or PhD training alone. In other examples, a two-year overlap is acceptable for combined specialist-PhD training.
Many countries have made efforts to limit the PhD training time to 3 or 4 years during which the candidates are demonstrably capable of gaining sufficient research training and clinical competence to later run a research laboratory or a clinical study in a junior faculty tenure track position. These recommendations clearly imply that the content of the PhD training must be subject to re-evaluation when taken in the context of clinical research training. A presently overlong incubation period is a world-wide problem that is only addressable by taking risks: the risk that some less than globally trained clinicians are capable of providing excellent clinical service in defined areas; and that less than globally trained researchers are capable of research breakthroughs in high-risk, high-reward areas.

B. Consider rewards for combined career tracks (both financial compensation and prestige) and eliminate the present financial and career disadvantages.

1.2 Improve the junior and senior faculty clinical research career path
After completion of their formal MD-PhD training, a clear albeit competitive and demanding career track should be available for the best candidates, first as postdoctoral fellow (preferably a combined clinical care/clinical research position with a 50:50 time commitment balance, instead of now frequent 80:20 positions), followed after a few years by a tenure or tenure track equivalent pathway with a clearly defined system of orderly advancement with feed-back and accountability, which should enable rising investigators to operate on a longer time scale to engage in high-risk, high-reward research. Included in a more formal system of advancement should be an emphasis on research supervision at every career step.

1.3 Allow junior clinical faculty scientists to compete for independent research grants

1.4 Consider the creation or an expansion of clinical research positions with a 50:50 clinical care/(clinical) research assignment [with carefully protected research terms!] for (potentially lifetime) renewable long-term (5–7 year) appointments and back-up to full-time clinical care positions for excellent clinicians-clinical scientists (apart from the full-time academic positions).

1.5 Create added value and add prestige to research experience of MDs and clinical specialists by attributing promotional advantages and other potential career benefits for research experience. Heads of important clinical units/departments in academic (or equivalent) hospitals should insofar as is possible have a research track record. The hospital (as well as the university) leaders should clearly, in words and deeds, articulate their appreciation for the research performance of their clinical staff.

2 RECOMMENDATION TWO: Improve the research funding portfolio for clinical researchers.

Researchers in all disciplines, worldwide, are familiar with highly competitive funding systems and can survive in such an environment provided that the grant funding process is transparent and reasonably fair, that prospects within the competition for funding approach or exceed > 30%, and if the level of funding matches the likely costs of the planned research. The existing specific funding system for clinical research in both countries is not perceived as fulfilling all these criteria. Evidently funding for clinical research now comes from EVO/ALF sources, academic institutional support, general (private) research funding agencies and a variety of other channels. The funding systems in European countries are diverse and are usually quite different from the US situation of a major single medical research funding agency (NIH). Researchers (including clinical scientists) have learned how to navigate the existing systems, and the present funding mechanisms in Sweden and Finland (and the rest of Europe) should and probably cannot be transformed into the US system, certainly not within the near future. Several models could be envisioned for creating optimal circumstances for clinical research, as good researchers and stable, fair and competitive funding institutions gradually mutually adapt (and hopefully grow) in the interests of both parties to achieve the best benefit from investments. The panel suggests that a simplified dual system for clinical research might generate the best results and cost-efficiency for Sweden and Finland.

2. A Funding based on EVO/ALF monies, should continue to compensate the academic center and hospitals for their teaching and research efforts, with the following suggestions for improvements:

- The funding should be substantial and provide financial stability for a horizon of at least five years. The extra costs for these academic responsibilities above routine health care costs are estimated to be around 15–25% in several international analyses.
- The funding should be indexed to past research performance.
- The funding should be walled off from regular health care service provision (Cooksey 2006), and clearly focus on direct and indirect costs for clinical research, including coverage of infrastructure for clinical research and potentially even include the salary for paramedical/technical/secretarial support for clinical research units.
- The funding mechanisms should be competitive and transparent and provide for short and long-term programs.
- Scientific merit should have a major impact on, and evolve as the major driving force for funding; such a strategy stimulates good scientists to search for and invest in internal and external collaborations and to create a critical mass whenever and wherever needed. This support of scientific excellence would also increasingly be perceived as an investment by university and hospital management leaders and is also a driving force for optimal cost-efficacy of research investments. Such a mechanism can initially be operational for each country but in the future regional or even pan-European competition for excellence might predominate.

- A minor exception to a ruthless excellence-based funding scheme could be targeted support for universities and hospitals handicapped by political, social or strategic circumstances. Examples of potential recipients of such subsidy include the smaller academic centers working in remote areas with low population density.

2. B A definite need exists for a well-funded national agency to support clinical research; this institution might best be part of the existing national research funding agencies to avoid administrative duplication. This new agency should provide competitive funding for clinical research projects of junior and senior faculty clinical scientists, according to the following principles:
- Peer-reviewed competitive funding driven by scientific excellence and clinical relevance.
- Grants should allow and even encourage high-risk, high-reward research, and/or long-term scale if well motivated.
- Preference for clinical investigator-driven clinical research, largely or totally independent from industry or for-profit institutions.

3 RECOMMENDATION THREE: Mount a clear uniform strategy for governance of academic hospital from top management to daily practice.

The relationship between hospital management and clinical research and teaching is troublesome worldwide. However, clinical research and teaching needs an accessible and cooperative health care system, including a tertiary care or academic hospital. Conversely, a good tertiary care center gains from academic activities of teaching and research even in daily clinical practice. The present system in both countries creates continuous and increasing tensions and frustrations because of lack of clear responsibilities and long-term strategic priorities.

The incompatibilities of these competing interests need to be clearly addressed and resolved as well as possible. The panel therefore strongly recommends that both countries and their counties should establish a joint long-term research strategy for universities and hospitals. The goals of the hospital and university should be aligned as much as is feasible. The top leadership of clinical departments or units should recognize the importance of and facilitate implementation of clinical research and teaching and endeavour to optimize the working conditions of the staff and faculty.

Several potential governance options are worth considering. One is a common health care center, with the faculty of medicine and academic hospital run by the same administration. Another is a long-term contract between the health care system and academia. Whatever the practical solution, it should give equal footing to excellent health care AND clinical research and teaching, so that one is not subordinated to the other. Corollaries of this equivalence are that financial research support is well fenced off from use for non research purposes, that sufficient protected time must be guaranteed for clinical research and that clinical care not be compromised from its mission by understaffing. Technical and administrative support for both activities should help to implement these difficult goals. Top clinical appointments should be based on clinical and academic records and supplemented with managerial assistance or with management training.

However the management solution is worked out, the strategic implications should be that the communication and shared goals between the university and hospital be increased to the point that the interdependent units function as a single institution with a truly unified viewpoint and a conviction that clinical research is a top priority, not to be subordinated to the hospital's focus on delivering clinical care under financially constrained circumstances. The underlying principle should be that clinical research is equivalent in importance with clinical care, as it is crucial to enabling the delivery of premier, cost-effective clinical care. This principle should direct conduct of business at all levels of the relevant organisations.

Compliance with these recommendations requires vision and a long-term commitment to their implementation, but most importantly, sufficient and stable financial support. The Panel is unanimous in its forceful admonition that the recommendations will be followed to stimulate clinical research and training, to maintain and strengthen optimal health care and to assure the training of outstanding clinicians and clinical scientist of the future.

Other suggestions and recommendations

4 Core facilities and technical and administrative support

Both clinical service and clinical research require affordable access to state-of-the-art laboratory support facilities and technical and administrative assistance.

The Panel recommends an in-depth analysis as to how to assure that these support modalities are available in the centers. Depending on local conditions, such facilities may be dedicated solely to research or to clinical care or else may be usable for both activities. In some cases core facilities existing in basic science units may be adaptable to the needs of clinical investigators. The specific services provided by the core facilities, e.g. imaging, chemical, histopathological and microbiological analyses, informatics, statistics, microscopy, etc., should be determined by the research programs of the centers and designed to optimize cost-effectiveness and ready access by investigators. While such core facilities are essential for all medical research centers, others could serve as national or regional core facilities so that their international profile is further enhanced and recognized.

Clinical research is a team effort and needs professional technical and administrative support. Frequently, this teamwork requires long-term involvement of non-MD scientists, and service support in form of operating personnel (e.g. for biobanking) for technical, paramedical (e.g. data ICT management) and administrative support for procurement and accounting activities.

Core facilities, a stimulating intellectual environment and ample career opportunities are major asset for attracting and retaining internationally top-qualified researchers.

5 Mobility and internationalisation

Science is a globally competitive activity. Scientific training and the continuous adaptation to rapidly emerging novel technologies require exposure to other scientists and research groups. Adherence to these principles is evident from the documented increase in collaboration between Swedish and Finnish researchers. In the countries

with the highest research output national (for large countries such as US) and international mobility during training is the rule among researchers, and such research experience outside the center where they received training or tenure is frequently mandatory.

The Swedish and Finnish research communities should seriously evaluate the handicaps of their systems that limit the net scientific exchange within their country and especially with the rest of the world. Strategies could be focused on exchange programs for junior post-docs and the reactivation of attractive sabbatical leave systems. The present Swedish system of automatic permanent positions to medical specialists-in-training is strongly counterproductive to (inter)national mobility and is probably a major handicap for competitive appointments based on scientific excellence.

6 Research funding from sources other than the government

The funding of clinical research should be largely supported by public money, but the panel as well as all the centers visited were receptive to the idea that it is not only appropriate but essential to mine research funding from sources other than the government. The time lines depicting public and private research investment in the USA reveals the widening gap between the two, with private (primarily industrial) funding now being several-fold higher than the public. The international financial crisis could imply that this gap may widen worldwide. Industry funding, while important, does not address the need for long-term support of high-risk, high-reward research and is understandably driven by potential economic return on investment. Therefore, tax laws should be modified to stimulate gifts to the centers' research programs, and this potential largesse may help these centers buffer the vagaries of grant funding successes and of national politics or economic fluctuation. Examples of enormous value from private philanthropy in biomedical research include the Rockefeller, Whitehead, Broad, Ludwig, Hughes, Van Andel, Hunter and Burnham Institutes in the USA, The Welcome Trust in the UK, or the Wallenberg Foundation in Sweden.

7 Collaboration with private sector and intellectual property commercialization

An in-depth analysis of the role and impact of the medical/clinical research by for-profit organisations engaged in diagnostic, drug or device innovations with or without support by governments is beyond the scope of the panel evaluation. However, such research depends on the presence and cooperation of academic medical researchers and clinical research centers. Therefore, public support for top quality clinical research will obligatorily have a major benefit for industry-driven clinical research in both countries.

Industry wants the best possible services from academic or clinical research centers as expert partners for clinical trials. Major investments in clinical research centers – from investments in excellent scientists, infrastructures, team members to management support – in the US and UK may serve as guidance. Such actions and support are needed to restore or enhance the position of both countries in the global clinical trial competition.

However, both countries are also aware of the strategic advantage and economic potential of research innovation. The Panel therefore suggests maximal exploitation of the investigator-ownership of intellectual property that appears currently to be unique in Sweden and Finland for academic researchers. For many reasons, the expropriation of inventions by academic institutions has resulted in a highly inefficient system for technology transfer. Entrepreneurial investigators are far more likely to see academic projects through to the clinic than academic bureaucrats. Such investigators should serve as role models. In addition, returns on investment to investigators appear currently to be one of the most promising ways to convey that the risks of research have potential financial returns to offset the current lack of differentiation between rewards for research-free clinical work and clinical investigation. Most centres have now some type of technology transfer offices (TTO) and support for protection and valorisation of intellectual property rights. Some centers currently have excellent expertise, while others are still in an early incubation phase. Given the priority for close contacts between scientists and TTOs, some type of public support for these offices is probably needed for the nearby future but better collaboration between these offices and exploiting the best expertise of each center may create added value.

The IP organization should be improved by further professionalization of the staff (national or international) cooperation, so that the inefficiencies of the current system can be corrected, although each institution should have access to its own technology transfer office,

8 Bureaucracy

That a common complaint was the increasing bureaucracy that at all levels hinders the optimal working conditions and efficiency of scientists is hardly surprising. All levels of governance should regularly review their internal procedures and eliminate unnecessary administrative burdens.

9 Equal opportunity

Scandinavian countries have a very good international reputation with regard to equal opportunity (including gender) policies for all aspects of society including for performing research. Nevertheless, applying imaginative attention to minimizing the constraints gender issues impose on young researchers should remain a high administrative priority.

10 Clinical research funding

The above actions will require a substantial increase in clinical research funding but the lessons from the NIH experience should be kept in mind: plan steady long-term growth rather than a stutter-step approach based on politics.

11 Documentation

Given the magnitude of additional investment and the radical nature of some of the changes in organization recommended by the Panel, the Panel believes it might be prudent and useful for the centers to develop a set of metrics in addition to bibliometric analysis to monitor the effect of any investments and changes made. This effort could involve preparing computerized systems for tracking information currently obtainable only with difficulty and at the same time brainstorming to assess what benchmarks are useful and add them to the monitoring system. A few parameters that come to mind based on the Panel visits could include average ages of trainees at various stages of preferment, compensation data, documentation of mentoring systems, time allocations and satisfaction surveys.

The Panel members realize that the implementation of their recommendations and suggestions have major implications for the research and health care policies of Sweden and Finland. Indeed, this will require a long-term strategy, a serious financial and organizational effort, and drastic implementation plans at all levels of their organizations. They therefore strongly recommend that both countries create a mechanism of supervising as to follow up the realization of these recommendations and their consequences for clinical research and health care in both countries.

Roger Bouillon *Lisbeth Tranebjærg* *Tom Stossel*

References

Advancing Research in Science and Engineering 2008, American Academy of Arts and Sciences, Cambridge, MA. http://www.amacad.org/arisefolder/ariseReport.pdf.

EMRC White Paper 2008, 6.12.2007, www.esf.org => Publications.

EMRC Forward Look, 2009, http://www.esf.org/fileadmin/links/EMRC/FL_IDCT.pdf.

Cooksey David, 2006. A Review of UK Health Research Funding, The Stationery Office, Great Britain.

Glänzel Wolfgang, Debackere Koenraad, and Meyer Martin, 2008. *'Triad' or 'Tetrad'? On global changes in a dynamic world*, Scientometrics 74: 71–88.

Glänzel Wolfgang and Schubert Andras, 2005. *Domesticity and internationality in co-authorship, references and citations*, Scientometrics 65: 323–342.

Hill Derek, Rapoport Alan I., Lehming Rolf F, and Bell Robert K. 2007. *Changing U.S. output of scientific articles: 1998-2003.* National Science Foundation, Division of Science Resources Statistics, Directorate for Social, Behavioral, and Economic Sciences, NSF 07–320 (Arlington, VA).

NIH response to the Conference Report request for a plan to ensure taxpayers' interests are protected 2001. NIH Office of Technology Transfer (OTT). http://www.ott.nih.gov/policy/policy_protect_text.html.

Roberts Ffrangcon, 1952. *The Cost of Health,* Turnstile Press, London.

Schacht WH, 2006. *The Bayh-Dole Act: Selected Issues in Patent Policy and the Commercialization of Technology*. Congressional Research Service (CRS) Report for Congress. Document RL32076. Washington, DC, 1–14. http://www.ncura.edu/content/educational_programs/sites/49/handouts/docs/Monday130/M130F11.pdf.

Världsklass! Åtgärdsplan för den kliniska forskningen, SOU 2008:7

Winkmann G., Schlutius S., and Schweim G.H., 2002. *Publication languages of impact factor journals and of medical bibliographic databank*. Deutschland Medizinische Forschungsrichte 127: 131–137.

Young Neal S., Ioannidis John P.A., and Al-Ubaydli Omar, 2008. *Why current publication practices may distort science.* PLoS Med 5(10): e201. doi:10.1371/journal.

Appendices

A. Terms of Reference

This document sets out the standard Terms of Reference applicable to the Panel as well as to the Coordinator. The contents of this document are relevant both to the evaluators and the units being assessed. This document should be read in conjunction with the Guidance for Faculties, which will be used by the units being assessed (hereafter referred to as the unit) when preparing their evaluation documents. The unit refers to the Faculty of Medicine and respective university hospital that is involved in the evaluation.

1 Background and purpose

Discipline and research field evaluations are one of the key elements in the long-term development of research and science policy. The Research Council for Health of the Academy of Finland and the Special Inquiry Commission of Clinical Research in Sweden in collaboration with the Swedish Research Council have decided on a joint effort to evaluate clinical research both in Finland and Sweden.

It is apparent that many of the obstacles affecting the quality of clinical research are not specific for Sweden or Finland. Recruitment of clinical investigators, infrastructure resources, and collaboration between the university and the health service are common to most countries. However, these challenges may have been solved in different ways. It would therefore be valuable to conduct this evaluation and use possible suggestions presented by the Evaluation Panel in a synergistic way in Sweden and Finland.

The present evaluation consists of an external assessment by an international Evaluation Panel performed with similar aims both in Finland and Sweden. The primary objective of the evaluation is to discuss the overall quality of clinical research in Finland and Sweden, to determine the strengths and weaknesses in general, and of major areas of clinical research. Furthermore, how the infrastructure, translational research, and interaction with industry are supported and developed. It would also be valuable if the expert panel could compare Finland and Sweden to countries where clinical research has improved during recent years. Another aim is to identify strategies to promote the career development of clinical researchers.

2 Definition of the field to be evaluated

The field to be evaluated consists of clinical medical research. It may include research from other areas of medical sciences ONLY if they are vitally linked to clinical research, and the research in question uses the university hospital or the university hospital resources. The evaluation will be carried out at the faculty level, and individual researchers or research groups will not be evaluated.

3 Organisation

The evaluation is commissioned by the Research Council for Health of the Academy of Finland and the Special Inquiry Commission of Clinical Research in Sweden in collaboration with the Swedish Research Council. The Councils appointed a Steering Group to lead and support the execution of the evaluation.

The members of the Steering Group are:
- *Kalervo Väänänen*, Professor, Chair of the Research Council for Health, Academy of Finland, Chair of the Steering Group
- *Kari Raivio,* Chancellor, University of Helsinki
- *Olle Stendahl,* Professor, Special Inquiry Commission of Clinical Research in Sweden
- *Håkan Billig,* Professor, Secretary General of Medicine, Swedish Research Council

4 International Evaluation Panel

The external evaluation will be carried out by an international Panel of independent high-level experts.

The Academy of Finland and the Swedish Research Council will jointly invite fifteen renowned scientists as evaluators:

Chair (Panel 2 chair)
- Professor *Roger Bouillon*, K.U. Leuwen, Belgium Department of Experimental Medicine

Panel 2 members
- *Ingrid Agartz*, University of Oslo, Norway
- *Henning Beck-Nielsen*, University of Southern Denmark, Denmark
- *Margaret A. Liu*, ProTherImmune, Lafayette, CA, USA
- *Karen Luker*, University of Manchester, UK

Vice Chair (Panel 1 chair)
- Professor *Lisbeth Tranebjærg*, University of Copenhagen, Denmark

Panel 1 members
- *Ariane de Agostini*, University of Geneva, Switzerland
- *Stein Evensen*, University of Oslo, Norway
- *Peter Sleight*, University of Oxford, John Radcliffe Hospital, UK
- *Susanne Suter*, University of Geneva

Vice Chair (Panel 3 chair)
- Professor *Tom Stossel*, Harvard Medical School, USA

Panel 3 members
- *John W. Sear*, University of Oxford, John Radcliffe Hospital, UK
- *Helgi Valdimarsson*¸ University of Iceland
- *Jørgen Vestbo*, University of Copenhagen and University of Manchester
- *Jens Zimmer*, University of Southern Denmark

5 Objectives of the evaluation

The evaluation of clinical research in Finland and Sweden in 2008 will be used as a tool in decision making by the funding authorities, and in developing research structure and quality of clinical research in both countries. It is also a way to improve the public support to clinical research in the future.

Performing the evaluation at the same time with shared aims and background material is an excellent opportunity to compare and develop clinical research in Finland and Sweden.

Evaluation objectives are:

1. Evaluation of the overall quality of clinical research
2. Recognition of strong and weak research areas
3. Evaluation of the differences between disciplines
4. Comparison of the differences in clinical research in Finland and Sweden
5. Assessment of the adequacy and allocation processes of funding?
6. Recognition of the platforms where basic and epidemiological research are efficiently linked to clinical research
7. Assessment of future prospects of clinical research in Finland and Sweden
8. Assessment of the quality and volume as well as problems in career development of young physician-scientists

6 Evaluation criteria

The basic unit to be evaluated by the Panel is the clinical research carried out in the Faculty of Medicine and the respective university hospital.

The Panel is asked to give a written statement of:

- Quality and status of research
- Clinical research strategy
- Characteristics of academic staff

And recommendations on:

- How to improve linkage between clinical research and health care system
- How to improve career development of young medical doctors aiming at a research career
- Recommendations for developing clinical research in the future
- Recommendations for organizations which fund and steer clinical research
- How to improve industrial collaboration

6.1 Quality and status of research

The quality and status statement is based on the evaluation documents submitted by the units. The Panel members will have the opportunity to complete this information during their site visits.

Important issues to be considered include:
- What is the international quality and status of clinical research in Sweden and Finland?
- Which clinical research fields are strong and which are weak?
- What are the differences between successful and non-successful fields of clinical research?
- What are the differences in clinical research in Sweden and Finland?
- How innovative and challenging are the current clinical research lines in both countries?
- What is the status of ongoing clinical trials in terms of funding/number/quality?
- What is the level of internationalization?
  - Are there differences between Sweden and Finland?
  - How to increase researcher exchange?

Status of funding:
- Is the EVO[1]/ALF[2] funding allocated in the best possible way?
  - if not, how to improve the allocation methods
- What is the status of EU funding?
- What is the status of NIH funding?

6.2 Strategy of clinical research

Important issues to be considered include:
- Are the aims of the institution realistic?
- Is it possible to reach the set aims?
- What kind of actions should be taken in order to reach the aimed level?
- Is there strategic funding in the faculty for developing clinical research?

6.3 Linkage between clinical research, health care system, industry and other research fields

The Panel is asked to write feedback about the interaction between research and health care system. The feedback is to be based on all the evaluation documents as well as interviews. The Panel should especially consider health care improvements,

1 EVO funding (erityisvaltionosuus): The EVO funding is defined in the law on special health care. According to it University hospitals and other health care units receive reimbursement for additional expenses caused by education of physicians and dentists as well as scientific research. The Government decides the amount of EVO funding annually. Allocation of EVO funding is based on education (number degrees/ months used for teaching) and research (publications in health sciences). The guidelines are set annually by the Ministry of Social Affairs and Health.

2 ALF funding: ALF-funding is proportionally allocated directly to the six county councils with medical schools. The ALF agreement between the Government and the County Councils regulates how and for what the funding is allocated. Parts of the funds are received as reimbursement for additional expenses caused by education of physician and part for supporting clinically relevant research at the medical schools. The allocation between the six county council/medical schools is based on the number of medical students and the research staff, but does not relate to overall scientific output. Distribution strategies within each University hospital and faculty vary from mostly large core funding to quality-driven allocations.

technology transfer and cooperation with other sectors of society. Bearing in mind that the assessed research field is medicine, the Panel should pay special attention to the contribution to treatment or health-political regulations and norms as well as to the relevance of the research on a national and international level.

Important issues:
- Are there platforms where basic research is efficiently linked to clinical research?
- How fruitful is cooperation between the unit and the communities ultimately applying the results of the research?
- Is research relevantly focused with respect to the future scenarios of the national as well as international developments?

6.4 Career development of young medical doctors aiming for research

The interest on pursuing research career has diminished among young medical doctors recently both in Finland and Sweden. In order to keep up a high, international level of research activity, new young professionals are needed.

The Panel is asked to consider the reasons for lack of interest for a research career.

Important issues:
- What kind of administrative/financial/society related/doctoral training related changes would be needed?
- How should the graduate school system be developed?
- What is the status of funding in doctoral studies?
- What is the academic and non-academic (business R&D, administration) need for research doctorates in the field, and how well is it met with the current intensity of doctoral training?
- How could the research career be made more attractive to young medical doctors?
- How to combine clinical work with research career?
- Should there be shortcuts for MDs contemplating a research career?
- How to strengthen the career development of clinical researchers, both MDs and non-MDs?

6.5 recommendations for developing clinical research in the future

The Panel is asked to provide recommendations for the future development of the research field. The Panel will need to consider that the recommendations should be focused mainly on the field, not on single units, research groups or researchers.

Key issues to be addressed are:
- What are the recommendations for developing clinical research in the next 5/10/15 years?
- What are the recommendations for the Medical Faculty and university hospital for developing clinical research?
- What opportunities and challenges does clinical medical research have?
- Future prospects of clinical research in Finland and Sweden

6.6 Recommendations for funding and steering organizations

What are the recommendations for the universities, Research Councils and government for developing clinical research?

7 Tasks, responsibilities and working arrangements of the Panel

In conducting the expert evaluation, the Panel members will base their examination on desk research at home on the basis of the background information provided. Ultimately, this will supplement their view during the site visits in Finland and Sweden.

The Panel members will set responsibilities within the Panel and together with the evaluation Coordinators. All evaluation documents are provided by the evaluation office. For the full description of the evaluation documents please see the Guidance for Faculties Form (Appendix 1), which will be used by the faculties and university hospitals being assessed when preparing their evaluation documents.

7.1 Desk research

Desk research will be carried out before the site visits. The material includes

- Bibliographic information (provided by the Steering Group)
- Data from the units
  - Amount of funding, and fund allocation processes
  - List of ongoing clinical trials
  - Description of status and strategy of clinical research
  - Description of international activities in the unit
  - Description of recruitment processes

7.2 Site visits and interviews

The panel of 15 members will be divided into three sub-panels, each led by a chair or a vice chair. Each sub panel will visit 3–4 institutions both in Finland and Sweden. Each site visit lasts one day.

The site visits will consist of the following sessions:

- Presentations and discussion with the executives of the Medical Faculty and university hospital
- Interview of a subset of researchers, for example:
  - Heads of units (research)
  - Professors, senior staff, postdoctoral researchers, visiting foreign scholars
  - PhD students, junior researchers

The Panel should meet at the end of each day to write down the conclusions and impressions made during the site visit day. The specific timetable and instructions will be provided by the evaluation office in due time.

7.3 Confidentiality and secrecy

The Panel members undertake not to make any use of and not to divulge to third parties any public or non-public facts, such as information, knowledge, documents or other matters communicated to them or brought to their attention during the performance of the evaluation. Confidentiality must also be maintained after the evaluation process has been completed.

Swedish citizens and citizens of other countries have the right to read official documents held by public authorities. The principle of public access means that the general public and the mass media newspapers, radio and television are to be

guaranteed an unimpeded view of activities pursued by the government and local authorities. This means that documents which is sent to public authorities is a public document. Working papers, however, is not public until the process is completed.

7.4 Publicity of the evaluation material

The evaluation and the ratings are not public and for official use of the Academy of Finland, the Swedish Research Council and the Special Inquiry Commission of Clinical Research in Sweden only. Once the evaluation has been completed, panellists are required to return all documents to evaluation coordinators. The evaluation report is not public and only for official use until publication.

The evaluation report including the main recommendations is based on the evaluation criteria. The evaluation report will be written and edited by the Panel members (main responsibility of the Panel Chair and Vice Chairs) with the assistance of the Evaluation Coordinator. Prior to final editing and publishing, the units being assessed are given the opportunity to review the report to correct any factual errors. The final evaluation report will be published in parallel in Finland and Sweden. Part of the evaluation results will be included in the final report of the Special Inquiry Commission of Clinical Research in Sweden led by Professor Olle Stendahl.

7.5 Conflicts of interest

The Panel members are required to declare any personal conflicts of interest. They must disqualify themselves if they can in any way benefit from a positive or a negative statement concerning the institute under evaluation. They must also disqualify themselves in the following circumstances:

- They have close collaboration with persons working at the institution to be evaluated (e.g. have co-authored a scientific article, research plan or funding application during the past three years, or are planning to co-author one/some of these during the near future).
- They have acted as a superior, subordinate or instructor of persons or research groups at the institution during the past three years
- One person working at the institution is a close person to them. A close person is:
  1) their spouse (also *de facto*), child, grandchild, sibling, parent, grandparent or a person otherwise especially close to them (e.g. fiancé/e or a close friend), as well as their spouses (also *de facto*),
  2) a sibling of their parent or his/her spouse (also *de facto*), a child of their sibling, their previous spouse (also *de facto*),
  3) a child, grandchild, sibling, parent or grandparent of their spouse as well as their spouses (also *de facto*), a child of a sibling of their spouse,
  4) or a half-relative comparable to the above mentioned.

The Panel member is also disqualified if his/her impartiality may otherwise be questioned, or if they feel that he/she has a conflict of interest and is therefore disqualified to evaluate the research group.

Therefore, if a panel member feels unable to evaluate a research group, he/she must notify the Academy as well as the other Panel members of it as soon as possible. The clarification of all conflict of interest matters must preferably be done during the first Panel meeting.

7.6 Declaration

Accepting the task as a member of an evaluation Panel, I guarantee not to disclose the information I get as panel member and not to use it for anybody's benefit or disadvantage as it is stipulated in paragraph "Confidentiality". Further, I affirm that if I have a conflict of interest I will immediately inform the Academy as well as the other panel members of it and step aside.

8 Timetable of the evaluation process

2008 *Feb*	Appointment of the Steering Group
2008 *Jun*	Appointment of the Evaluation Coordinator
	Planning of the evaluation process
	(incl. gathering of background material)
	Defining scope, execution and objectives of evaluation
2008 *Jul–Sep*	Appointment of the Evaluation Panel
2008 *Sep–Dec*	Preparation and delivery of evaluation documents
	Planning and organizing the site visits
2008 *Nov–Dec*	Site visits
2009 *Jan–Mar*	Preparation of the report
2009 *Mar*	Publication and release of the report (seminar)
2009 *Apr–*	Follow-up of the implementation of the provided recommendations

9 Coordination of evaluation

The evaluation process is operationally coordinated by the Evaluation Team: Coordinator Riikka Pellinen from the University of Kuopio, and Coordinator Anette Gröjer from the Swedish Research Council, Science Adviser Sara Illman and Director Mikael Fogelholm from the Health Research Unit of the Academy of Finland. The duties of the Coordinators are to compile the evaluation documents collected from the field as well as to assist the Panel during the site visits and the report editing. The administrative support and assistance for the evaluation Steering Group and Coordinator as well as the practical details of the seminars and site visits are organised by the Academy of Finland and the Swedish Research Council.

10 Funds

The evaluation is funded by the Research Council for Health of the Academy of Finland and the Special Inquiry Commission of Clinical Research in Sweden in collaboration with the Swedish Research Council. These counterparts will pay an expert fee to the Panel member so that the costs will be split equally between the Academy of Finland and the Swedish Research Council. All travel expenses related to the Panel's visits and accommodation will be covered or reimbursed.

Helsinki, October 30th 2008

Kalervo Väänänen
Chair of the Steering Group
Research Council for Health
Academy of Finland

B. Members of the Evaluation Panel

Brief introduction

Roger Bouillon, *Professor,* MD, PhD
Chair of the Panel
Catholic University of Leuven, Belgium
Endocrinology

Roger Bouillon is Professor and Chairman of endocrinology (internal medicine) at the University and University Hospital of the Catholic University of Leuven, Belgium. Hormonal regulation of bone metabolism and vitamin D is the primary focus of his research, although the laboratory of endocrinology and endocrine clinic is also involved in many other endocrine diseases (especially diabetes and androgens).

Professor Bouillon has been Vice-President and Coordinator of Research Policy of the K.U. Leuven and member of the Board of Directors of the University and University Hospital (1995–2005) and is still a member of the Science Advisory Board of the Flemish Government (President of Science Policy Commission). He is a member of the Royal Academy of Medicine (Belgium) and a Fellow of the Royal College of Physician (London 2000). He has been the secretary (founding member) and later President of the European Board of Endocrinology (UEMS 1988–2002).

Professor Bouillon has several positions of trust within the European Science Foundation (ESF); he is a Board member of the European Medical Research Council (EMRC) and the European Space Agency Life Science working group (LSWG) and of the Space Science Committee (ESSC). Further, Professor Bouillon is a Board Member and President of the International Bone and Mineral Society (IBMS) and of the vitamin D workshop Inc. He is a (co)author of more than 400 peer-reviewed articles.

Thomas Stossel, *Professor,* MD, PhD
Vice Chair
Harvard Medical School and Brigham and Women's Hospital, Boston, USA
Haematology, cell biology, academic-industry interaction

Thomas P. Stossel is currently Director of the Division of Translational Medicine at the Brigham and Women's Hospital and American Cancer Society Professor of Medicine at Harvard Medical School. He was head of Hematology and Oncology at Massachusetts General Hospital from 1976 until 1991 and Co-Director of the Hematology Division at Brigham & Women's Hospital through 2006.

Stossel's basic research concerns fundamental mechanisms of cell motility. This research led to discoveries that may reduce critical care complications of major injury and impact platelet transfusion therapy. His policy interests concern physician and researcher interactions with private industry. He was President of the American Society for Clinical Investigation and Editor in Chief of its *Journal of Clinical*

Investigation and served as President of the American Society of Hematology. He is a member of the National Academy of Sciences, the American Academy of Arts and Sciences, and the Institute of Medicine. He is Editor-in-Chief of *Current Opinion* in Hematology, a member of the Lasker Awards Jury, a member of the Board of Directors of Zymequest Corporation, and a founding scientist of Critical Biologics Corporation. He is a (co)author of more than 200 peer-reviewed articles.

***Lisbeth Tranebjærg**, Professor,* MD, PhD
Vice Chair
University of Copenhagen, Denmark
Neurobiology, clinical genetics, audiology

Lisbeth Tranebjærg is Professor of Clinical Audiogenetics at the University of Copenhagen and head of the Audiogenetic Research group started in 2002. Professor Tranebjærg has held positions both as head of the Department of Medical Genetics at the University Hospital of Tromsø, and as Professor in Medical Genetics at the University of Tromsø. From 2001 to 2006, she held a Research Professorship in Genetic Audiology at the University of Copenhagen.

Professor Tranebjærg's research is focused on molecular and clinical genetic studies of various hereditary conditions with hearing impairment as a prominent finding. Unique patient and family material, collected over a 10-year period at the University of Tromsø, Norway, and Danish clinical material as well as a Danish research based deafness register is used for genetic linkage mapping aiming at the identification of new deafness and deaf-blindness genes. She is a (co)author of more than 160 peer-reviewed articles.

Professor Tranebjærg has served as a member of several program committees of the Norwegian Research Council and as a member of the European Society of Human Genetics' Public and Professional Policy Committee and as co-editor on the boards of several Medical Genetics journals.

Figure 10. Panel chairs. Vice Chair *Tom Stossel* (left), Vice Chair *Lisbeth Tranebjærg,* and Chair *Roger Bouillon.*

Panel members

Ingrid Agartz, *Professor,* MD, PhD
University of Oslo, Norway
Psychiatry, imaging

Ariane de Agostini, *Docent,* PhD
University of Geneva, Switzerland
Reproductive Biology and Medicine

Henning Beck-Nielsen, *Professor,* MD, DMedSci
University of Southern Denmark, Denmark
Endocrinology, diabetes

Stein Evensen, *Professor,* MD, PhD
University of Oslo, Norway
Internal Medicine, Gastroenterology and Haematology

Margaret A. Liu, *Professor,* MD, PhD
ProTherImmune, Lafayette, CA, USA
Immunology, Internal Medicine, Endocrinology and Metabolism

Karen Luker, *Professor,* BNurs, PhD, FMedSci
University of Manchester, UK
Nursing, Public Health

John W. Sear, *Professor,* MD, PhD
University of Oxford, John Radcliffe Hospital, UK
Anesthesiology

Peter Sleight, *emeritus Professor,* MD, PhD
University of Oxford, John Radcliffe Hospital, UK
Cardiology

Susanne Suter, *Professor,* MD, PhD
University of Geneva, Switzerland
Paediatrics

Helgi Valdimarsson¸ *Professor,* MD, PhD
University of Iceland
Immunology, Dermatology

Jørgen Vestbo, *Professor,* MD, DrMedSci
University of Copenhagen and University of Manchester
Respiratory Medicine

Jens Zimmer, *Professor,* MD, DrMedSci
University of Southern Denmark
Neurology

C. Questionnaire for the Medical Faculties / University Hospitals

Evaluation Of Clinical Research in Finland and Sweden 2008–2009 – Questionnaire for the Medical Faculties/University hospitals

1 Funding

Give the amount of budgetary, external, EVO/ALF, and contract research funding in the Medical Faculty and university hospital in given years

Source	2000	2001	2002	2003	2004	2005	2006	2007
Faculty funding a								
External funding b								
EVO/ALF Funding c								
Contract research d								

a: Governmental budget appropriations
Finland: Perusrahoitus
Sweden: Intäkter från vetenskapsområdesanslag
b: All external research funding
Finland: Ulkopuolinen rahoitus
Sweden: Extern finansiering

c: **Finland:** EVO funding (erityisvaltionosuus): The EVO funding is defined in the law on special health care. According to it, university hospitals and other health care units receive reimbursement for additional expenses caused by education of physicians and dentists as well as scientific research. The Government decides the amount of EVO funding annually. Allocation of EVO funding is based on education (number degrees/months used for teaching) and research (publications in health sciences). The guidelines are set annually by the Ministry of Social Affairs and Health.

Sweden: ALF funding: ALF funding is proportionally allocated directly to the six county councils with medical schools. The ALF agreement between the Government and the County Councils regulates how and for what the funding is allocated. Parts of the funds are received as reimbursement for additional expenses caused by education of physician and part for supporting clinically relevant research at the medical schools. The allocation between the six county council/medical schools is based on the number of medical students and the research staff, but does not relate to overall scientific output. Distribution strategies within each University hospital and faculty vary from mostly large core funding to quality-driven allocations.

d: **In Finnish:** maksullinen palvelutoiminta
In Swedish: intäkter från uppdragsforskning

1.1. Describe the model used for allocating the budgetary funding within the Faculty for Clinical Research

1.1.1 How much of the total budget of the faculty is allocated for research and education, respectively?

1.2 Describe the funding processes within the faculty and university hospital

1.3 Infrastructure and core facilities either within the Faculty of Medicine or based on interfacultary structure (E.g.: biobanks, animal facilities, biomathematics recourses, sequencing facilities, imaging facilities and so on)

1.3.1 Major investments during evaluation period

1.3.2 Major deficiencies and plans on improving them

2 Research status and strategy

2.1 What is the research profile of your faculty?

2.2 Describe the strategy of Clinical research

2.3 Describe the current status of Clinical research

2.4 How is the quality of clinical research evaluated in your institution?

2.5 What is the level of research your institution aims at? (Top ten in the world, top ten in Europe, National leader?)

2.6 What are the main areas of translational clinical research?

2.7 What kind of connections/collaborations are you engaged in with the industry (including patents and start up companies)**?**

2.7.1 Describe the IP policies/management and incentives for investigators

2.7.2 List patents gained during 2000–2007

Patent	**Time (year)**

Add as many rows as needed

2.6 List clinical trials conducted during 2000–2007 along with the funding received for these. Also state whether the trial was sponsored by industry or not (sponsored vs. non sponsored)

Clinical trial	**Time** (year)	**Amount of funding**	**Funding source**	**Sponsored** (yes/no)	**Type of study** (single or multicenter)

Add as many rows as needed

3 Recruitment, mobility and collaboration

3.1 Describe your national clinical research collaborations

3.2 Describe your international clinical research collaborations

3.3 Describe your recruitment strategy for clinical researchers

3.3.1 Describe the career development model recommended by your faculty

3.4 Staff

	2000	2001	2002	2003	2004	2005	2006	2007
Appointed professors (number)								
Professors who defended their thesis in the same university (%) [a]								
Physicians ending formal training (number)								
Physicians in clinical training (number)								
PhDs with medical background (MD)/PhDs with scientific background (MSc)(number)								
International activity								
Visiting researchers (coming)[b]								
Visiting researchers (going)[b]								

a: at least for 2007
b: in months

4 SWOT analysis of clinical research

The maximum number of issues on each field is 5.

STRENGTHS	**WEAKNESSES**
1.	**1.**
2.	**2.**
3.	**3.**
4.	**4.**
5.	**5.**
OPPORTUNITIES	**THREATS**
1.	**1.**
2.	**2.**
3.	**3.**
4.	**4.**
5.	**5.**

5 General remarks

D. Bibliometric Analysis of Medical Publications from Finland and Sweden

Staffan Karlsson, *Adam Jonsson*
Swedish Research Council
Department of Research Policy Analysis

Contents

Summary

This report provides an overview of Finnish and Swedish publications in medical journals based on publications covered by Web of Science. Comparisons are made using averages for the three years 2004 to 2006 and development over time is illustrated using time series from 1982 to 2006. National averages are compared with a range of other countries. Detailed comparisons are made at a national level among medical universities in Finland and Sweden as well as the national production of publications in different subject fields. Some statistics on international cooperation are also presented.

1 Introduction

A bibliometric analysis of a field, such as medicine, can contribute to an overview of the productivity and through citation levels indicate weak and strong fields as well as organisations. For individual papers the number of citations is not a reliable quality indicator, but citation statistics are considered to be relatively robust quality indicators for aggregated data based on large numbers of publications.[1] Commonly, a set of indicators are used to produce a more complete picture.[2]

In this report journal subject assignments are used to identify medical publications. Most journals indexed in the database are assigned one or more subject fields. In total 255 subject fields are defined, 63 of these are medical. These 63 medical fields contain about half of all publications in the international journals covered by the Science Citation Index database. Scientists at medical institutions publish to a large extent in medical journals; 91% of the publications from medical university institutions (including university hospitals) in Sweden appear in medical journals[3]. Looking at all Swedish publications in medical journals, 80% of them have addresses

1 See e.g. Case & Higgins (2000) Adams (2005), Aksnes (2005) and Moed (2005) for details on the relationships between citations and quality and Wallin (2005) for a critical discussion
2 See e.g. van Leeuwen et al (2003)
3 Swedish Research Council Report 13:2006, page 32–33.

belonging to medical institutions, 14% are from authors at non-medical life science institutions[4] and the remaining are spread mainly among technical and social sciences institutions. Thus publications in medical journals are strongly dominated by researchers at medical institutions.

This report analyses Finnish and Swedish publications in medical journals. The publications from these two countries are first compared internationally. Secondly, national publications are scrutinised in detail with respect to subject field distribution, contributing organisations etc. The statistics is partitioned into the two macro-fields, biomedicine and clinical medicine (defined below), as well as into the 63 medical subject fields defined in the database.

2 Methods

2.1 Identification of medical publications

There are 255 subject fields defined by Thomson Reuters in the Science Citation Index database. Journals are attributed one or more subject fields and all publications are thus assigned subject field(s) depending on the journal where they are published. These 255 subject fields is in turn grouped into 14 macro fields, of which two are medical; biomedicine (14 subject fields) and clinical medicine (49 subject fields).[5] Thus, 63 fields are classified as medical. The subject fields within each medical macro field are defined in appendix 1. In total 6,200 journals are attributed to one or more of these subject fields. In addition to publications in medical journals, publications in multidisciplinary journals with apparently medical contents were also included (see next paragraph for details).

In one case a subject classification is made for individual papers; most of the publications (more than 90%) in journals that are classified into 'multidisciplinary sciences', such as Nature and Science, are reclassified based on who these papers cite and from whom these papers receive citations. Some publications (< 10%) in the multidisciplinary journals could not be reclassified using this method mainly due to no or very short reference list and few citations.

2.2 Address corrections

Finnish and Swedish author addresses to the medical publications have been checked and corrected. Five Finnish and six Swedish universities with medical faculties in focus. The Finnish universities are: Helsinki, Kuopio, Oulu, Tampere and Turku universities and the Swedish universities are Karolinska Institute, Linköping University, Lund University, Umeå University, University of Gothenburg and Uppsala University. The publications from the university hospitals are included in the corresponding university.[6] Publications from the Ludwig Institute in Uppsala are included in the Uppsala university publications.

4 The Swedish definition of natural sciences (biology, chemistry, geosciences and physics) and agricultural sciences (agronomy. forestry and veterinary sciences).

5 The classification into macro fields is mainly based on a grouping produced by SPRU, Science and Technology Policy Research, University of Sussex, UK.

6 Karolinska Institute includes: Karolinska hospital, Huddinge university hospital and Södersjukhuset (Stockholm South General Hospital). Gothenburg University hospital (Sahlgrenska Academy) includes the hospitals: Drottning Silvias barn- och ungdomssjukhus, Högsbo, Lillhagsparken, Mölndal, Sahlgrenska och Östra. Lund University includes Lund university hospital and Malmö university hospital.

Finnish addresses were checked by the Academy of Finland and the Swedish addresses by the Swedish Research Council.

For the international comparisons one entity is the EU15-group, i.e. the member countries when the European union had 15 member states; Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom. The other 12 member states are relatively small in terms of publication volume[7].

2.3 Bibliometric methods

The study is based on the publication database at the Swedish Research Council. This database contains the material from Science Citation Index Expanded 1982–2008.[8][9] When the statistics for this study was compiled, the database was updated with publications indexed until the first quarter 2008.

All statistics presented here are based on:

1) The publication types *Article* and *Review*. The article type has been extended to include also the *Letter* type. Over all letters currently make up 3.3% of the extended article type. The proportion of letters varies, however, markedly among subject fields.
2) All statistics, with one exception (see point 4 below), are based on so called fractionalised publications i.e., each country or organisation is credited a fraction of each publication in proportion to its share of all author addresses given on the publication. The publication volume is thus the sum of all fractions. Citation averages are calculated as weighted averages where each publication is weighted using the address-weight. In those cases where a publication is allocated more than one subject the publications is also fractionalised among the subjects. For example, a publication that has two subjects, the publication is split between these with 0.5 publications to each field. In this case the statistics is based on the combined address and subject weight. By this procedure the sum of all fractions (of countries, organisations and/or subject fields) always sums to the total sum of publications analysed.
3) Citation statistics are presented as *field normalised mean citation rates* 3 years after publication; the publication year and the two following years.[10] Since citation rates are presented also for 2006 the statistics for this year are preliminary, the final three quarters of 2008 needs to be added to the database before a complete 3 year citation window is obtained. Self citations are not counted;

7 Approximately 92% of the publications from all member states are produced by the EU15 group.

8 Certain data included herein are derived from the Science Citation Index Expanded® prepared by Thomson Reuters®, Philadelphia, Pennsylvania, USA© Copyright Thomson Reuters® 2006. All rights reserved.

9 The contents of Web of Science and the Science Citation index are very similar but not identical.

10 Highly cited publications are in most cases cited relatively much also shortly after publication. The number of citation three years after publications is closely correlated to citation rating after longer time spans (see eg. Glänzel & Garfield 2004, Vetenskapsrådet 2006).

all citations where one or more author name (with identical spelling) is found in both the cited and citing publications are defined as self citations. The field normalised citation rate is the number of citations per publication (CPP) divided by the average number of citations of all publications in the database from the same year, same publication type (article or review) and in the same subject field(s) (i.e., the field citation score, FCS):

Field normalised citation rate = CPP/FCS

A publication that is cited at the same rate as the world average thus obtains a citation rate of 1. If the number of citations are half that of the world average the rate becomes 0.5 and if the number is 50% above the world average the rate become 1.5 etc. Citation averages are calculated using the weights as defined under 2) above. Thus a publication where the authors represent four countries (one address to each country) the publication has the weight 0.25 in the calculation of the mean for respective country.

4) International cooperation, Section 4.3. is based on so called 'whole counts' i.e., not fractionalised data. The numbers of joint publications as well as their citation rates are calculated using whole counts.

All statistics presented are based on publications printed between 1982 and 2006. All citations registered in the database during the first quarter 2008 or earlier are counted.

2.4 Medical fields in the database

The volume of the entire medical field has increased by 23% during the last decade (2004–06 compared to 1994–96, Table 1). This growth is the combined effect of an increasing coverage of journals (the number of journals covered by the database increases successively) and increasing number of publications per journal. The volume in clinical medicine has increased more than that of biomedicine, 28% versus 17%. In the biomedical fields is Medicinal chemistry followed by Biochemical Research Methods showing the largest increase (+116% and +100% respectively). The biomedical fields show the largest decrease is Physiology and Microscopy (-8% and -11% respectively).

Within clinical medicine, five new subject fields were defined between 1996 and 2003. Some journals were reclassified into these fields retroactively and, as a result, the few publications in these fields appearing already in the 1980s create large relative increases between the two periods. Among these are *Health care sciences and services* and *Critical care medicine* which currently contain more than 2000 publications per year. Among the more established subject fields is *Clinical neurology* showing the largest increase (+59%). Another 12 subject fields increased 40% or more. A large field within clinical medicine that has declined markedly is *Medicine, General & Internal* (-16%). Also *Emergency medicine* has declined markedly (-30%).

The total current publication volume of all fields as well as the volume for Finland and Sweden are presented in Appendix 1.

Table 1. The number of medical publications indexed in the database per year during two periods; 1994–96 and 2004–06.

	Volume 1994–96	2004–06	Change
Medicine, total all subjects	310140	382902	23 %
Biomedicine, total	121967	142122	17 %
Chemistry, Medicinal	1797	3883	116 %
Biochemical Research Methods	2503	5003	100 %
Biotechnology & Applied Microbiology	5845	8748	50 %
Microbiology	7316	9998	37 %
Cell Biology	9322	12573	35 %
Anatomy & Morphology	865	936	8 %
Immunology	10556	11219	6 %
Biochemistry & Molecular Biology	33041	32779	-1 %
Physiology	5750	5292	-8 %
Microscopy	725	647	-11 %
Clinical medicine, total	188173	240661	28 %
Integrative & Complementary Medicine [A]	4	536	-
Health Care Sciences & Services [A]	25	2070	-
Neuroimaging [B]	29	633	-
Gerontology [A]	70	937	-
Critical Care Medicine [A]	318	2318	-
Clinical Neurology	6875	10917	59 %
Ophthalmology	4106	6352	55 %
Peripheral Vascular Disease	3514	5383	53 %
Rheumatology	2418	3671	52 %
Public, Environmental & Occupational Health	5915	8957	51 %
Geriatrics & Gerontology	1721	1656	-4 %
Pathology	4511	4322	-4 %
Medical Informatics	550	469	-15 %
Medicine, General & Internal	20153	16941	-16 %
Emergency Medicine	2179	1529	-30 %

[A] Field defined 1996 or 1997, some journals where changed retroactively
[B] Field defined 2003, some journals where changed retroactively

3 International comparisons

3.1 Production volume – current production

The countries discussed here are restricted to the 54 countries with at least 600 medical publications during the period 2004–2006, i.e., an average of at least 200 publications per year.

The publication volumes of the 25 most productive countries are presented in figure 1. These contribute to 93 and 94% of the world production[11] within biomedicine and clinical medicine respectively. The combined contribution of the USA and EU15 make up two thirds of the world production. The contributions from Finland and Sweden make up 0.7% and 1.5% respectively, in biomedicine and 0.7% and 1.6% in clinical medicine.

11 'World' refers to all publications in the database

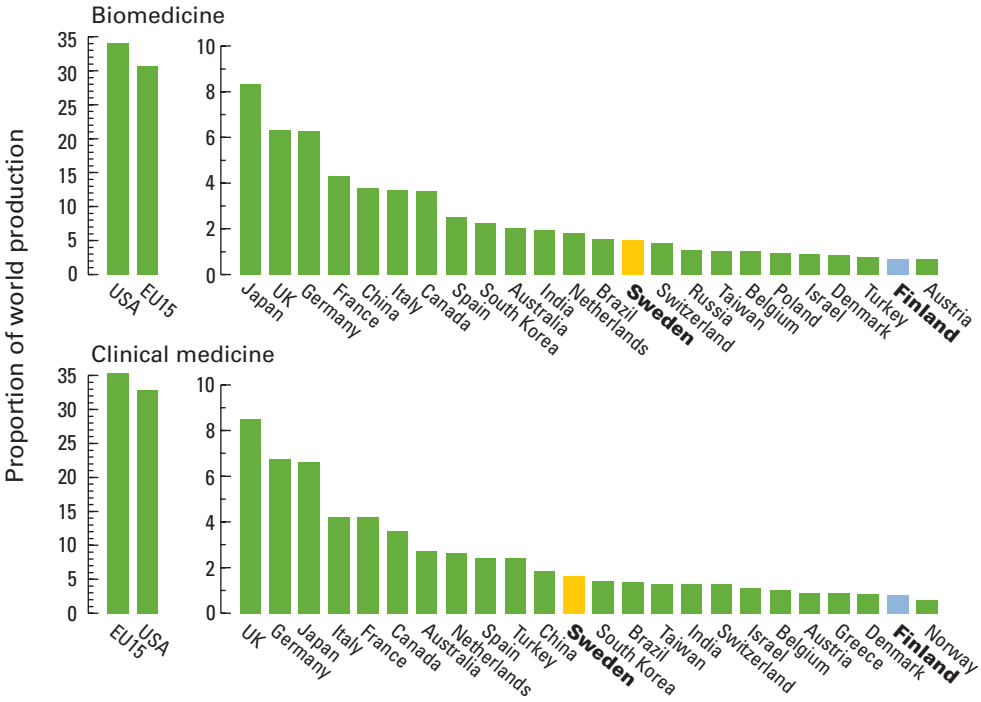

Figure 1. The 25 largest producers of publications in biomedicine and clinical medicine 2004–2006.

Countries appear at somewhat different rank positions regarding the number of publications in biomedicine and clinical medicine in Figure 1, indicating that the proportion between biomedical and clinical publications varies between countries. Among the countries included in Figure 1 these, Russia and China have the largest proportion of biomedicine (56% and 54% respectively, Figure 2) while Turkey has the largest proportion of clinical medicine (84%). Finland and Sweden respectively contribute with 67% and 65% of the clinical medicine publications.

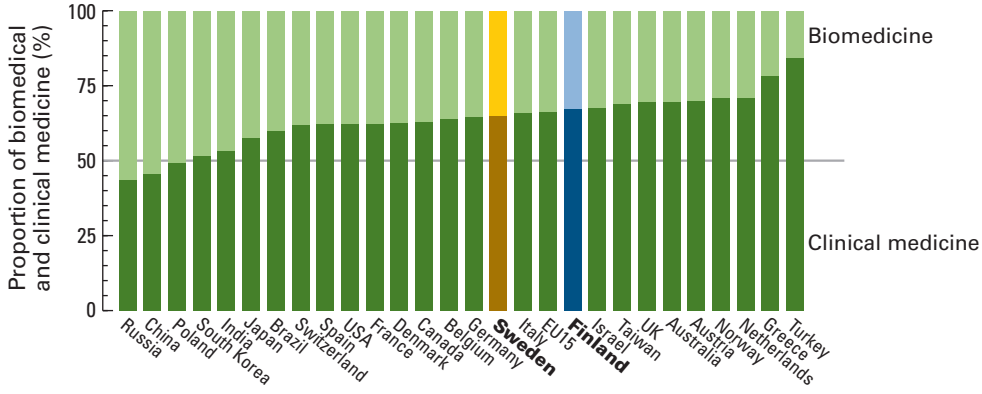

Figure 2. Relative contribution of biomedicine and clinical medicine to all publications in medicine for the countries presented in Figure 1.

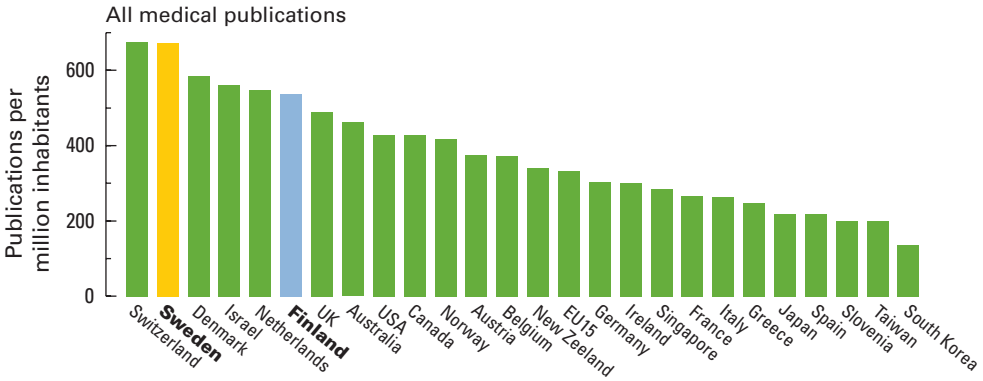

Figure 3. Per capita production of medical publications; publications per year and million inhabitants. Population statistics from OECD.

The dominance of USA and the EU15 group in terms of number of publications produced per year is of course an effect of their size and economical wealth. An alternative way to illustrate production volume is to relate it to population size, i.e., the *per capita* production of medical publications. Expressed in this way Switzerland is the most productive country closely followed by Sweden (Figure 3). Relative to population USA is ranked number 9, United Kingdom has rank 7 and Japan 21 while Finland has rank 6.

3.2 Production volume – development over time

Many traditionally large countries in terms of number of medical publications (USA, UK, Japan and others) have shown relatively small changes in the number of medical publications since the mid-1990s (Figure 4). Finland and Sweden also show relatively small changes; the volume for Finland has increased 13% the last decade while the Swedish production has decreased by 9%.

The number of papers in clinical medicine for the EU15 group passed that of USA during 1996. Currently (2006) the production of the EU15 group is 8% larger than that of USA. Regarding biomedicine, USA maintains a larger production than EU15 (34% versus 31% of the world production, respectively).

A number of new countries are emerging as important producers of medical publications (Figure 4 and Table 2). The most marked growth is shown by China with a growth of more than 600% during the last decade. In terms of volume of biomedical publications, China is ranked 5th in 2006 (the last year covered in this report) and had an average growth rate of 37% per year the last five years. If this pattern is maintained, China will pass Japan and United Kingdom during 2008 to become the second largest producer of biomedical publications.

In total 10 countries have more than doubled their production of biomedical publications in a decade and 15 countries have shown a similar pattern in clinical medicine. The countries with strongly growing volumes are mainly located in Asia with China, South Korea and Iran as the fastest growing. Some non-Asian countries (e.g. Turkey, Greece and Brazil) are also present on the list of fast growing countries (Table 2).

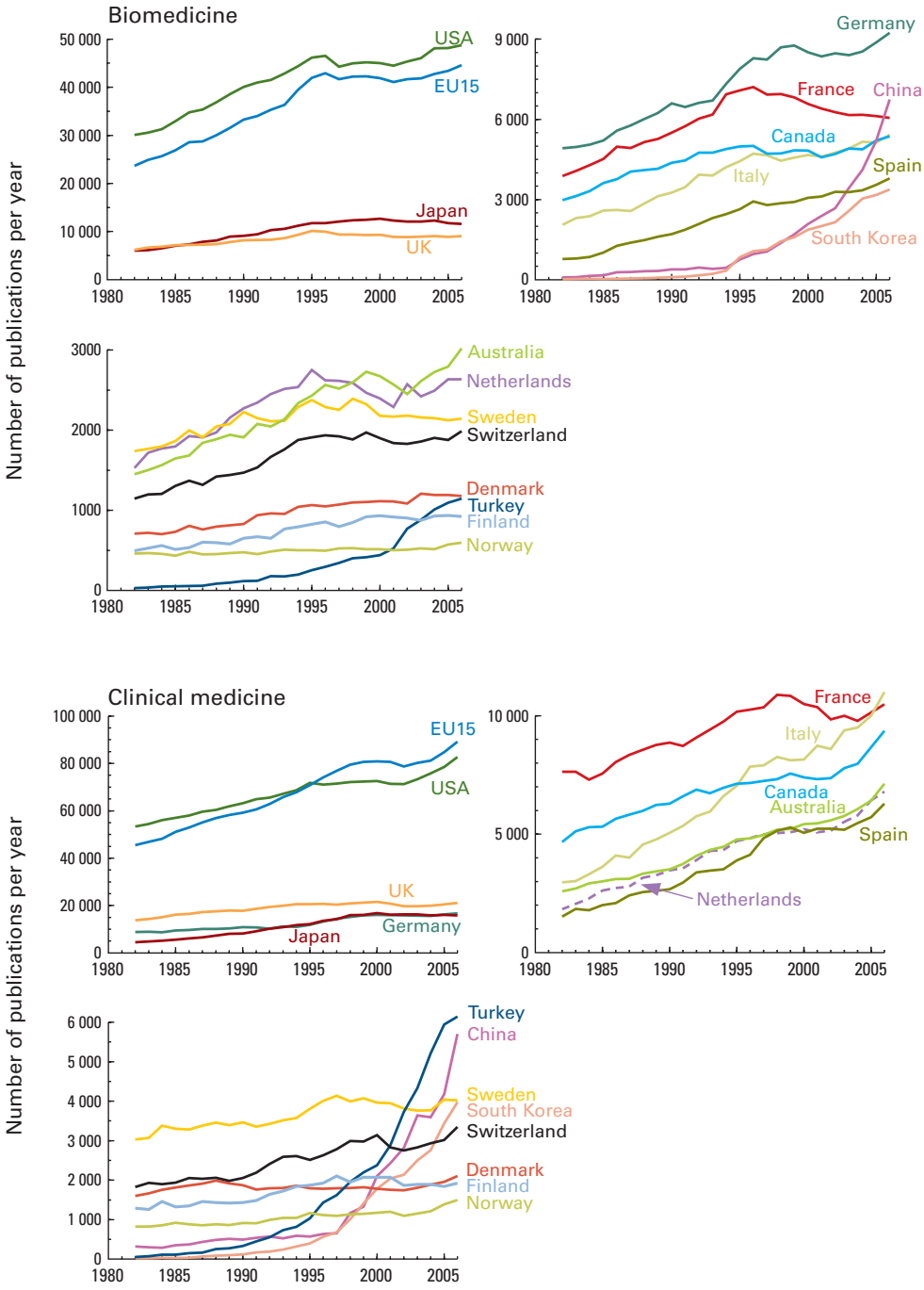

Figure 4. Number of publications per year for the 15 largest countries, Switzerland, Denmark, Finland, Norway and Sweden.

Table 2. The countries showing the fastest growth in terms of medical publication production. Only countries with an average of at least 200 publications per year during 2004–06 are considered.

Country	Number of publications per year		
	1994–96	2004–06	Change
Biomedicine			
China	718	5352	646 %
Iran	45	333	641 %
Turkey	250	1084	334 %
South Korea	750	3195	326 %
Thailand	87	299	242 %
Singapore	158	522	230 %
Brazil	797	2201	176 %
Portugal	233	539	131 %
Taiwan	660	1428	117 %
Greece	284	602	112 %
Clinical medicine			
Iran	55	590	967 %
South Korea	427	3390	694 %
China	600	4492	649 %
Turkey	1095	5766	427 %
Brazil	986	3282	233 %
Singapore	250	787	215 %
Thailand	173	497	187 %
Greece	747	2138	186 %
Poland	460	1245	171 %
Taiwan	1197	3143	163 %

3.3 Citation rate

In both medical macro fields the publications from USA have the highest average citation rate; 1.36 and 1.32 for biomedicine and clinical medicine, respectively (Figure 5A). In addition to USA two other countries stand out regarding the citation rate in biomedicine; Switzerland and United Kingdom. In clinical medicine the differences in citation rate within the top group behind USA is relatively small; six countries (including Sweden and Finland) have mean citation rates between 1.18 (Netherlands) and 1.09 (Finland).

The rank of Finland is 17 in biomedicine and 7 in clinical medicine. The corresponding positions of Sweden are 8 and 6.

Twenty years ago Switzerland was the leading nation when measured in terms of citation rates of biomedical publications (Figure 5B). In clinical medicine USA was outstanding. Since the field normalised citation rate by definition yields a global mean of one, the very high citation rates received by Switzerland and USA during the 1980s are very difficult to maintain as the quality of the publications form other countries improve. Further, the high values for USA during this period could partly be caused

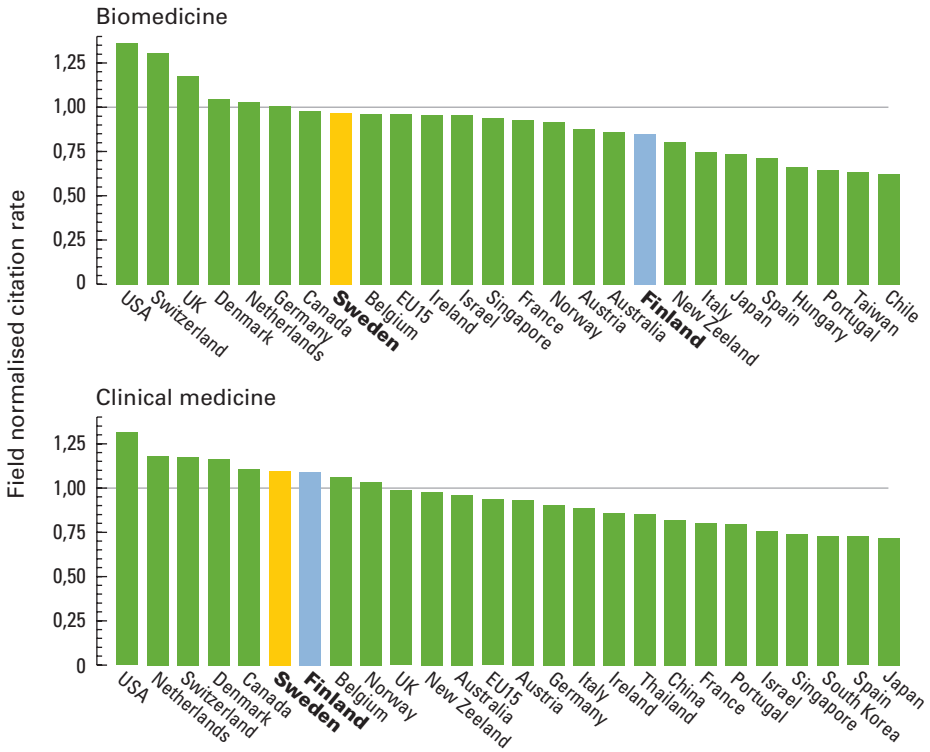

Figure 5A. The 25 most highly cited countries and the mean for the EU15 group. Only countries with at least 200 medical publications per year 2004–2006 are considered.

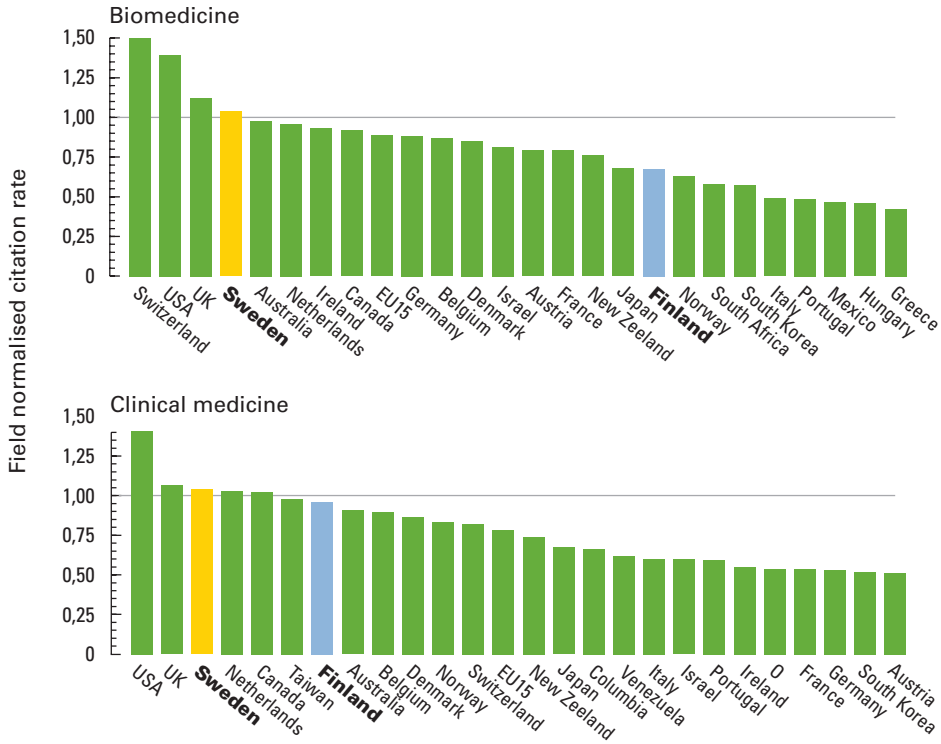

Figure 5B. The 25 most highly cited countries and the mean for the EU15 group during 1984–1986. Only countries with at least 200 medical publications per year 1984–1986 are considered.

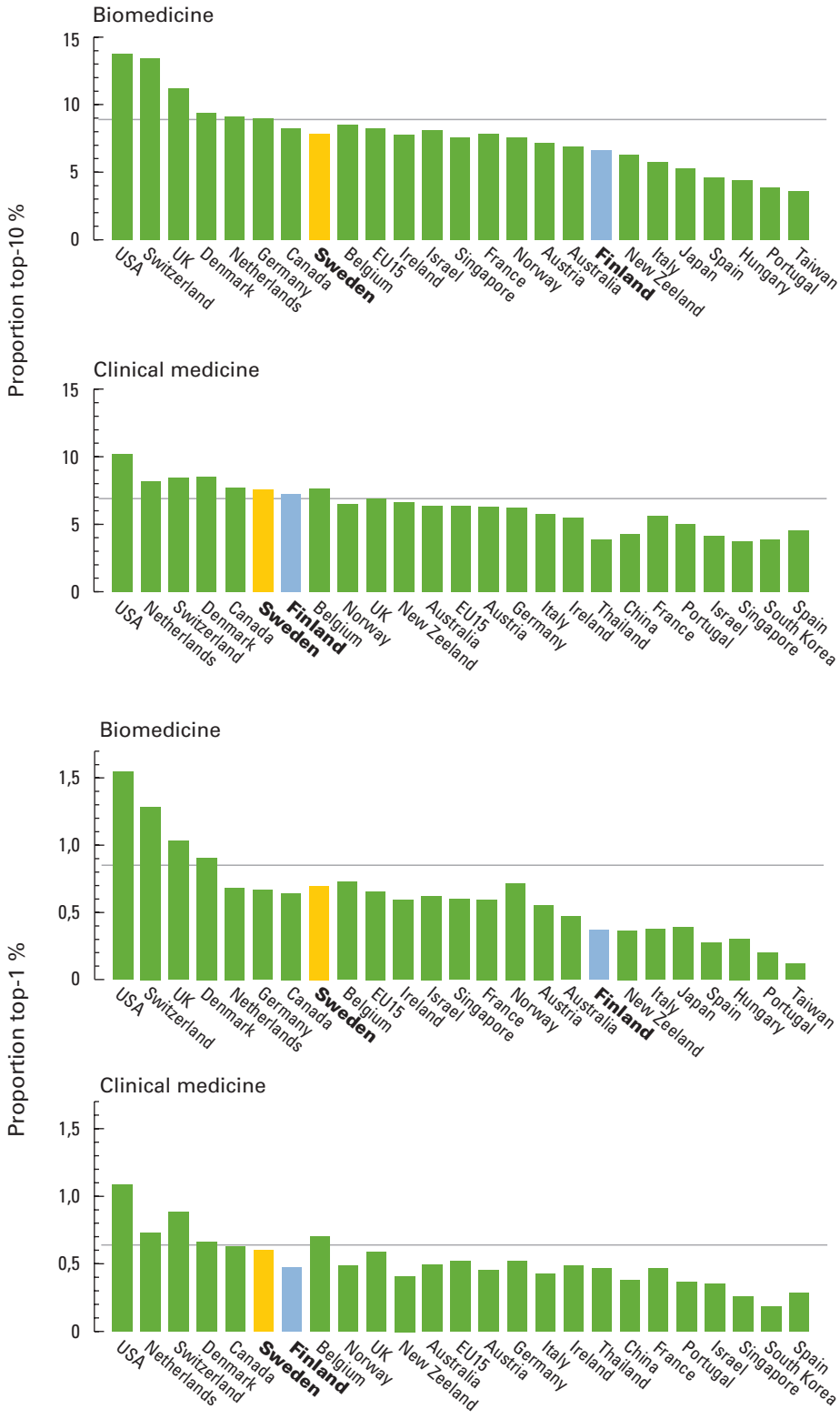

Figure 6. The proportion (%) highly cited publications using two definitions; among top 10% and top 1% or the world production. The figure present same selection of countries as Figure 3, also the order of the countries follows Figure 3.

by the database contents; it is compiled by an American company (Thomson Reuters) and they have successively improved the coverage of non-US journals. Thus the very high citation rates obtained by USA in the early 1980s could partly be due a stronger USA-focus of the database contents then.

Citations are very skewly distributed among the publications; a few get many citations while the majority gets few or none. The proportion highly cited papers therefore have a large impact on the mean for a country and is a quality indicator that complements the average citation rate. Below (Figure 6) are the proportion of highly cited publications presented using two definitions; among the top 10% or the top 1% of the world production (within a given year, subject field and publication type). We say that a publication is among the top 10% if it has more citations than 90% of all

Table 3. Countries with the largest change in mean citation rate. The ten with the largest increase, two or three with the largest decrease, Finland and Sweden are presented. Only countries with an average of at least 200 publications per year during 2004–06 are considered.

Field	Mean citation rate			Number of publications		
Country	1994–96	2004–06	Change	1994–96	2004–06	Change
Biomedicine						
South Korea	0.30	0.65	0.35	750	3195	326 %
Norway	0.63	0.95	0.32	501	561	12 %
China	0.23	0.54	0.31	718	5352	646 %
Singapore	0.68	0.99	0.30	158	522	230 %
Ireland	0.72	1.01	0.29	247	416	69 %
India	0.17	0.42	0.25	1499	2743	83 %
Denmark	0.80	1.04	0.24	1052	1188	13 %
Chile	0.39	0.62	0.23	147	229	56 %
Spain	0.52	0.74	0.22	2674	3566	33 %
Thailand	0.39	0.61	0.22	87	299	242 %
Sweden	0.84	0.96	0.12	2317	2138	-8 %
Finland	0.85	0.85	0.00	824	929	13 %
USA	1.41	1.36	-0.05	45686	48335	6 %
Switzerland	1.42	1.32	-0.09	1908	1923	1 %
Clinical medicine						
China	0.38	0.75	0.37	600	4492	649 %
Chile	0.23	0.52	0.29	329	441	34 %
Portugal	0.55	0.82	0.26	183	430	135 %
Czech Republic	0.37	0.62	0.25	223	584	162 %
South Africa	0.45	0.69	0.24	900	737	-18 %
Hungary	0.40	0.64	0.24	321	617	92 %
New Zeeland	0.73	0.96	0.22	829	905	9 %
Spain	0.54	0.74	0.21	3843	5820	51 %
Switzerland	0.95	1.15	0.20	2584	3099	20 %
Norway	0.86	1.06	0.20	1110	1367	23 %
Sweden	1.07	1.11	0.05	3796	3945	4 %
USA	1.35	1.31	-0.04	70534	79022	12 %
Finland	1.12	1.07	-0.05	1879	1886	0 %
Thailand	0.94	0.84	-0.10	173	497	187 %

publications with the given class. The proportion of the world production included in the top 10 or top 1% are thus somewhat lower than 10% and 1%.[12] The actual fractions of the world production included in the two groups are indicated in the graphs.

The comparatively high average citation rate of publications from the USA (Figure 5) can be explained by a large proportion of highly cited papers (Figure 6); 14% of USA's publications in biomedicine and 10% of the papers in clinical medicine are highly cited.

It can be noted that although Finland and Sweden have similar mean citation rates of their publications in clinical medicine (Figure 5) the proportion of papers that receive many citations is lower for Finland than for Sweden. This shows that the citations of the Finnish publications are more evenly distributed among the publications while the highly cited are relatively more important for the Swedish average.

In general there is a trend of decreasing differences in citation rates among countries; many lowly cited countries are showing increasing citation rates while a few (mainly USA) show a declining trend (Table 3, Figure 7). Naturally it is easier to make substantial improvements of very low citation rates than high ones. For example, the leading country, USA, is among the bottom three in terms of change in citation rate in both biomedicine and clinical medicine.

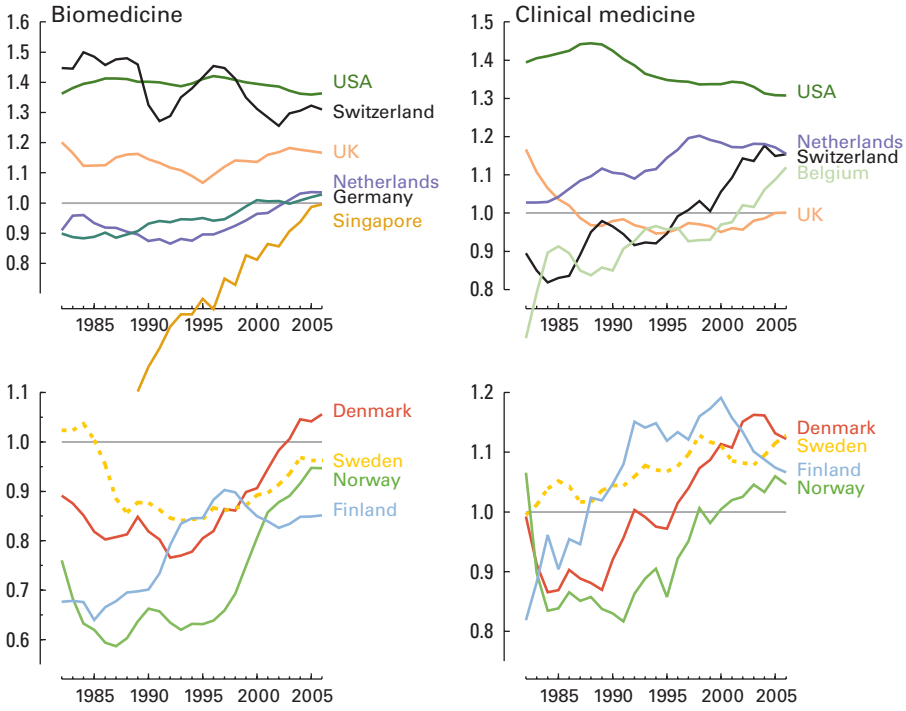

Figure 7. Field normalised citation rate 1982 to 2006 for a selection of countries (3-year moving averages). Note the varying scale on the y-axis.

12 The average 90th percentile limit for Swedish publications in 2004 were 17 and 12 citations in biomedicine and clinical medicine respectively, corresponding values for the 99th percentile were: 62 and 42 citations.

4 Finnish and Swedish medical publications

4.1 National data broken on subject fields

In both Finland and Sweden, Biochemistry & Molecular Biology is the largest field; it is increasing in volume in Finland (+28% the last decade) while it is decreasing in Sweden (-14%, Table 4). A similar pattern is shown by the third largest field for both countries Neurosciences.

Most fields that show fast growth are small fields with less than 100 publications per year (Table 5). Exceptions to this are, for example, for Finland *Endocrinology & Metabolism* (volume 146 publications per year, +41%) and for Sweden *Public, Environmental & Occupational Health* (volume 268 publications per year, + 57%).

For both Finland and Sweden, *General and Internal medicine* is the most highly cited field; more than 90% above world average (Table 6). For Finland this field has been obtaining increasing citation rates while the Swedish publications in this field are cited at decreasing rates. The field showing the largest increase in citation rate is for Finland *Anaestesiology* (+0.37) and for Sweden *Rheumathology* (+0.79).

Table 4. The largest medical subject fields 2004–06 and how they are cited for Finnish and Swedish publications.

Country	Volume		Mean citation rate		
Subject field	2004–06	Change[A]	1994–96	2004–06	Change
Finland					
Biochemistry & Molecular Biology	184.0	28 %	0.77	0.77	0.00
Endocrinology & Metabolism	146.4	75 %	1.09	1.13	0.04
Neurosciences	140.7	45 %	0.65	0.78	0.12
Oncology	133.5	63 %	1.05	0.83	-0.23
Public, Environmental & Occupat. Health	119.3	45 %	1.13	0.98	-0.15
Pharmacology & Pharmacy	115.9	6 %	0.92	1.13	0.21
Clinical Neurology	95.9	52 %	1.18	1.34	0.16
Genetics & Heredity	85.3	37 %	1.10	0.83	-0.27
Psychiatry	81.4	30 %	0.88	0.90	0.03
Surgery	80.7	5 %	0.65	1.12	0.47
Sweden					
Biochemistry & Molecular Biology	491.4	-14 %	0.74	0.96	0.22
Oncology	329.6	7 %	0.84	0.85	0.01
Neurosciences	278.2	-24 %	0.86	0.95	0.09
Endocrinology & Metabolism	270.3	22 %	0.96	1.06	0.10
Public, Environmental & Occupational Health	267.8	57 %	0.97	0.86	-0.11
Immunology	228.8	-16 %	0.55	0.74	0.18
Pharmacology & Pharmacy	218.8	-13 %	1.20	1.22	0.03
Surgery	162.4	-30 %	1.03	1.33	0.29
Cell Biology	161.8	17 %	0.71	0.77	0.06
Clinical Neurology	151.0	18 %	0.99	1.43	0.43

[A] Change between 1994–96 and 2004–06

Table 5. The fastest growing subject fields between 1994–96 and 2004–06. The subject fields are restricted to those with at least 20 publications per year during the first period.

Country	Volume		
Subject field	**1994–96**	**2004–06**	**Change**
Finland			
Nutrition & Dietetics	27.4	49.1	79 %
Endocrinology & Metabolism	83.5	146.4	75 %
Oncology	81.8	133.5	63 %
Clinical Neurology	63.2	95.9	52 %
Microbiology	49.7	74.8	50 %
Peripheral Vascular Disease	33.7	50.7	50 %
Cell Biology	46.0	69.1	50 %
Biophysics	23.1	34.0	47 %
Biotechnology & Applied Microbiology	42.4	62.2	47 %
Public, Environmental & Occupational Health	82.1	119.3	45 %
Sweden			
Biochemical Research Methods	68.1	110.5	62 %
Nursing	49.4	79.3	61 %
Rehabilitation	39.6	62.9	59 %
Public, Environmental & Occupational Health	171.0	267.8	57 %
Biotechnology & Applied Microbiology	79.2	117.9	49 %
Respiratory System	53.1	66.7	25 %
Endocrinology & Metabolism	220.9	270.3	22 %
Medicine, Research & Experimental	74.0	89.2	20 %
Clinical Neurology	127.4	151.0	18 %
Cell Biology	137.9	161.8	17 %

Table 6. Most highly cited subject fields 2004–06. The subject fields are restricted to those with at least 20 publications per year during the first period.

Country	Mean citation rate			Volume
Subject field	1994–96	2004–06	Change	2004–06
Finland				
Medicine, General & Internal	1.76	1.94	0.18	65.8
Anesthesiology	1.20	1.61	0.41	53.3
Orthopedics	1.32	1.45	0.13	34.5
Clinical Neurology	1.18	1.34	0.16	95.9
Pathology	1.70	1.28	-0.42	35.0
Obstetrics & Gynecology	0.86	1.27	0.40	58.1
Biophysics	1.06	1.14	0.09	34.0
Pediatrics	1.33	1.14	-0.18	67.0
Dermatology	1.25	1.14	-0.11	20.5
Pharmacology & Pharmacy	0.92	1.13	0.21	115.9
Sweden				
Medicine, General & Internal	2.10	1.92	-0.19	141.1
Rheumatology	1.05	1.84	0.79	92.1
Anesthesiology	1.28	1.53	0.25	66.7
Dermatology	1.34	1.51	0.18	61.2
Clinical Neurology	0.99	1.43	0.43	151.0
Surgery	1.03	1.33	0.29	162.4
Dentistry, Oral Surgery & Medicine	1.18	1.32	0.14	149.9
Pharmacology & Pharmacy	1.20	1.22	0.03	218.8
Orthopedics	1.28	1.22	-0.07	90.3
Toxicology	1.07	1.21	0.14	66.7

Table 7 present the subject fields with the largest changes in citation rate over the last 10 years.

The development over time for the largest subject fields are presented in Figure 8 and 9.

Table 7. Subject fields showing the 10 largest increases and 5 largest decreases in citation rate between 1994–96 and 2004–06. The subject fields are restricted to those with at least 20 publications per year during the first period.

Country	Mean citation rate			Volume
Subject field	1994–96	2004–06	Change	2004–06
Finland				
Surgery	0.65	1.12	0.47	80.7
Anesthesiology	1.20	1.61	0.41	53.3
Obstetrics & Gynecology	0.86	1.27	0.40	58.1
Immunology	0.47	0.75	0.28	72.8
Physiology	0.52	0.77	0.25	29.3
Toxicology	0.87	1.10	0.24	32.5
Infectious Diseases	0.69	0.92	0.23	34.1
Pharmacology & Pharmacy	0.92	1.13	0.21	115.9
Ophthalmology	0.66	0.84	0.19	32.5
Medicine, General & Internal	1.76	1.94	0.18	65.8
Genetics & Heredity	1.10	0.83	-0.27	85.3
Cardiac & Cardiovascular System	1.42	1.06	-0.36	67.1
Peripheral Vascular Disease	1.34	0.94	-0.41	50.7
Pathology	1.70	1.28	-0.42	35.0
Gastroenterology & Hepatology	1.49	1.04	-0.45	45.3
Sweden				
Rheumatology	1.05	1.84	0.79	92.1
Clinical Neurology	0.99	1.43	0.43	151.0
Otorhinolaryngology	0.88	1.21	0.32	48.6
Surgery	1.03	1.33	0.29	162.4
Anesthesiology	1.28	1.53	0.25	66.7
Physiology	0.57	0.81	0.24	107.7
Biochemistry & Molecular Biology	0.74	0.96	0.22	491.4
Rehabilitation	0.87	1.07	0.20	62.9
Immunology	0.55	0.74	0.18	228.8
Dermatology	1.34	1.51	0.18	61.2
Biochemical Research Methods	1.16	1.05	-0.11	110.5
Medicine, General & Internal	2.10	1.92	-0.19	141.1
Allergy	1.35	1.12	-0.23	33.1
Ophthalmology	1.11	0.83	-0.28	64.4
Biotechnology & Applied Microbiology	1.38	0.97	-0.41	117.9

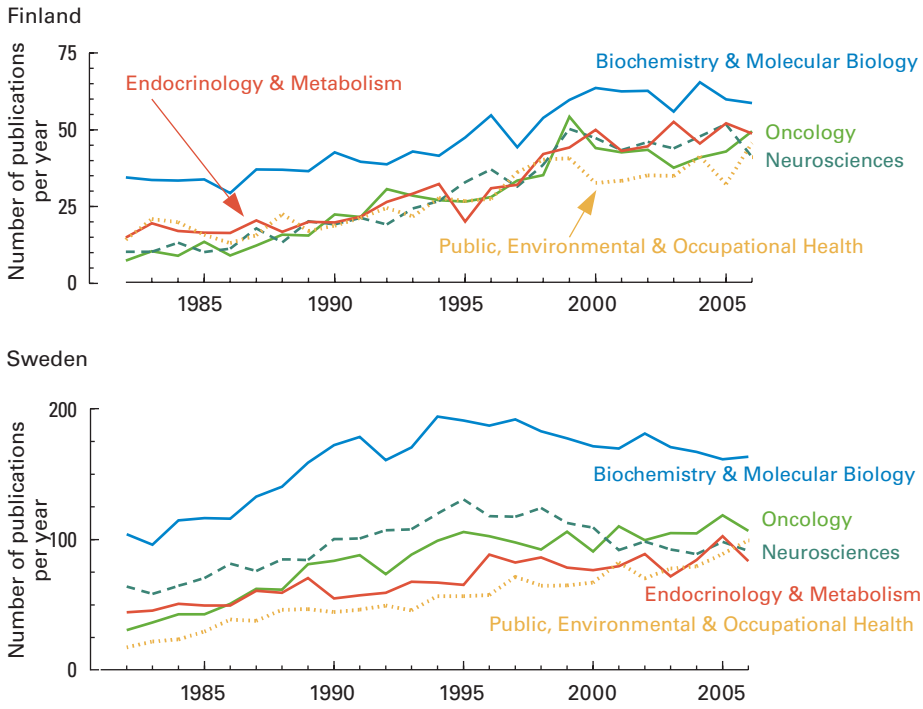

Figure 8. Number of publications in the five largest subject fields.

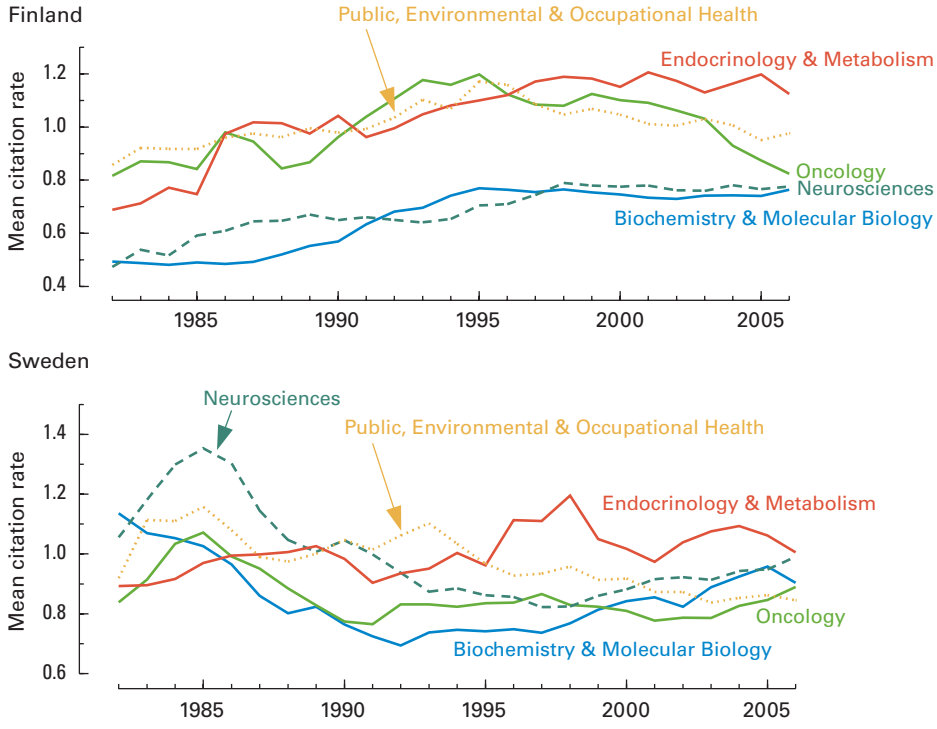

Figure 9. Mean citation rates for the five largest subject fields (5-year moving averages)

4.2 National data broken on organisations

The largest Finnish producer of medical publications is Helsinki University with more than one third (34%) of all Finnish medical publications (Table 8). Helsinki University is also the most highly cited Finnish organisation. After Helsinki University one finds Turku University (12% of Finnish medical publications), Kuopio University (11%) and Oulu (9%).

The largest Swedish producer of medical publications is Karolinska institutet (including associated university hospitals) with more than one quarter (27%) of all Swedish medical publications. Karolinska institutet is also the most highly cited Swedish organisation and the only one with a citation rate above the world average in biomedicine. After Karolinska institutet follows Lund University (16% of the Swedish medical publications), University of Gothenburg and Uppsala University (12% each).

Table 8. Number of publications per year and mean citation rate of Finnish and Swedish medical schools 2004–2006.

Country	**Total**		**Biomedicine**		**Clinical medicine**	
University	Volume	Citation rate	Volume	Citation rate	Volume	Citation rate
Finland						
Helsinki University	946	1.08	333	0.94	612	1.16
Kuopio University	297	1.04	108	0.86	189	1.14
Oulu University	242	0.89	64	0.76	178	0.94
Tampere University	228	0.91	58	0.74	170	0.97
Turku University	346	0.92	118	0.80	227	0.99
All other organisations	756	0.98	247	0.79	508	1.07
Total	2813	1.00	929	0.85	1885	1.07
Sweden						
Gothenburg University	744	1.10	203	0.87	542	1.19
Karolinska Institutet	1652	1.19	554	1.07	1098	1.25
Linköping University	295	0.86	76	0.62	219	0.94
Lund University	978	0.97	336	0.90	642	1.00
Umeå University	346	1.10	121	0.98	225	1.16
Uppsala University	715	1.02	316	0.95	399	1.08
All other organisations	1347	1.00	531	0.98	816	1.02
Total	6077	1.06	2137	0.96	3940	1.12

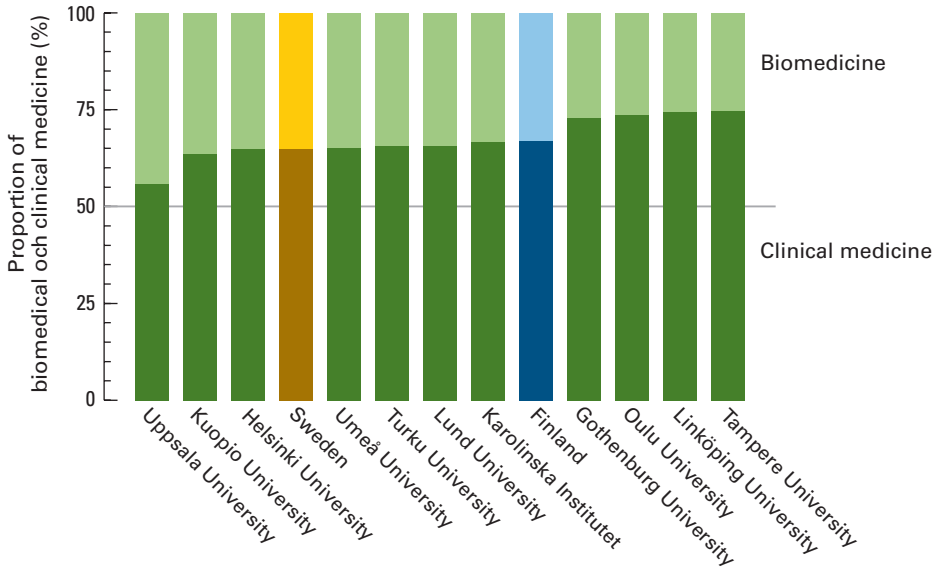

Figure 10. Proportions between publication volume of biomedicine and clinical medicine for Finnish and Swedish universities.

If the volume columns for biomedicine and clinical medicine in Table 8 are compared it is apparent that there is some variation in the proportions of these macro fields also among universities. This variation is illustrated in Figure 10. Among the universities analysed, Uppsala has the strongest focus on biomedicine; 44% of all publications from Uppsala are in journals classified as biomedical. At the other end of the gradient are Tampere and Linköping universities with 25% and 26% biomedicine respectively.

The development over time for the Finnish and Swedish universities is presented in Figure 11 (volume) and 12 (mean citation rate).

In Table 9, the university statistics are divided into subject fields. Only fields where respective university has with at least 20 publications per year are included in the table. For Finland three universities, Universities of Helsinki, Oulu and Turku have fields large enough to exceed this limit. The largest Finnish university, Helsinki, has 20 or more publications in 13 fields. For Sweden all universities has at least one subject exceeding the limit. For Linköping university there is only one field while the largest Swedish medical university, Karolinska institute, has 20 or more publications in 30 fields.

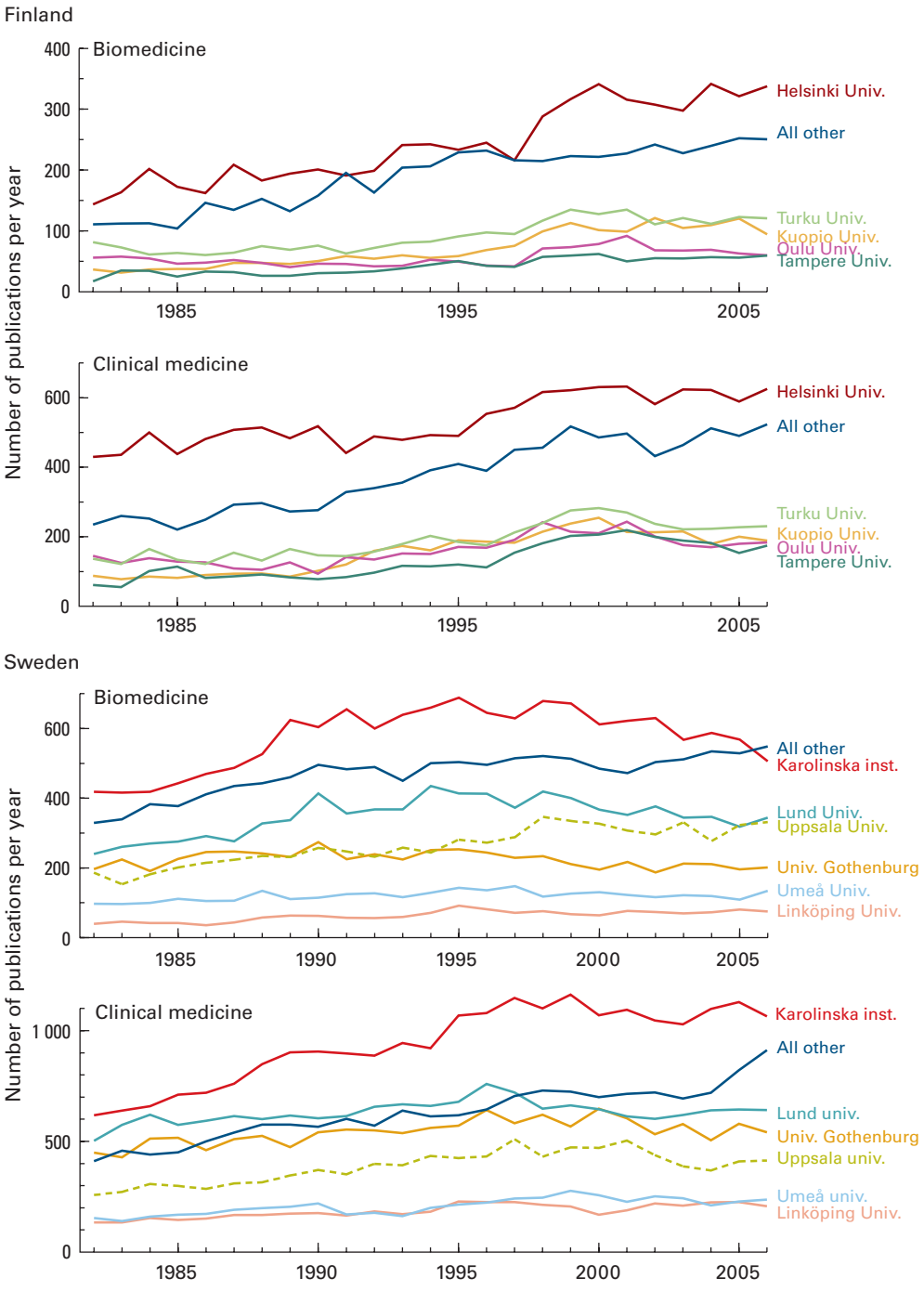

Figure 11. Number of publications per year from Finnish and Swedish universities.

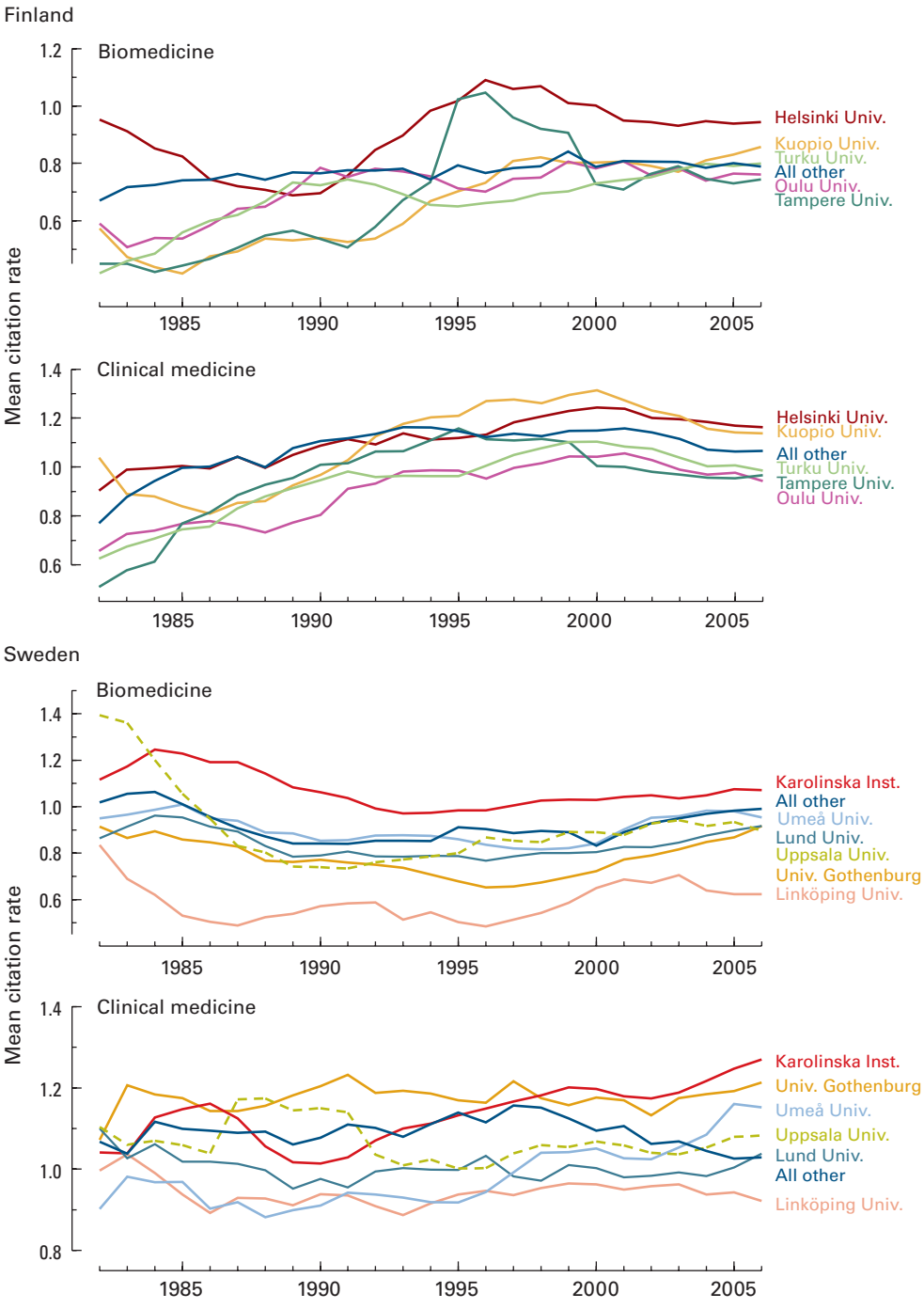

Figure 12. Average field normalised citation rate for the analysed Finnish and Swedish universities (5-year moving averages). Note the varying scale on the y-axis.

Table 9. Number of publications per university and subject field, 2004–2006. Only subjects where a university has produced at least 60 publications during the period are included (i.e. at least 20 publications per year).

University, subject field	Publications per year	Mean citation rate	Prop. top 10%	Prop. top 1%
Helsinki University				
Biochemistry & Molecular Biology	61.9	0.89	8.6	0.4
Neurosciences	56.8	0.90	6.0	0.3
Oncology	46.8	0.93	7.7	0.6
Pharmacology & Pharmacy	44.2	1.24	14.4	1.0
Endocrinology & Metabolism	43.0	1.29	13.6	1.2
Surgery	37.3	1.22	10.3	0.6
Genetics & Heredity	36.2	0.92	8.1	0.4
Microbiology	31.7	0.73	4.3	0.0
Clinical Neurology	29.8	1.26	8.1	0.4
Cell Biology	29.0	0.96	10.9	0.9
Biochemical Research Methods	22.0	1.38	19.8	0.9
Immunology	20.3	0.59	3.4	0.0
Medicine, General & Internal	20.2	1.71	9.2	0.3
Oulu University				
Biochemistry & Molecular Biology	21.6	0.80	8.9	0.0
Turku University				
Biochemistry & Molecular Biology	24.3	0.71	4.2	0.0
Endocrinology & Metabolism	24.1	0.94	8.7	0.0
Oncology	21.4	0.64	6.7	0.0
Gothenburg University				
Dentistry, Oral Surgery & Medicine	42.9	1.61	19.0	1.7
Endocrinology & Metabolism	40.9	1.17	8.4	1.4
Immunology	38.4	0.72	4.7	0.9
Clinical Neurology	34.6	1.28	7.5	0.8
Neurosciences	34.4	1.01	6.9	1.5
Biochemistry & Molecular Biology	32.9	0.84	6.7	0.2
Oncology	27.6	0.83	6.9	0.8
Cardiac & Cardiovascular System	27.2	1.48	7.4	1.6
Surgery	25.3	1.28	7.3	0.5
Pediatrics	22.6	1.90	19.8	1.9
Gastroenterology & Hepatology	21.8	0.92	7.2	0.4
Peripheral Vascular Disease	20.3	0.82	3.0	0.1
Karolinska institutet				
Oncology	129.2	0.94	8.2	0.2
Biochemistry & Molecular Biology	120.8	1.21	10.1	0.6
Neurosciences	113.0	0.98	7.0	1.0
Endocrinology & Metabolism	85.4	1.10	9.8	0.4
Immunology	77.9	0.83	6.8	0.7
Public, Environmental & Occupat. Health	75.5	1.16	9.2	1.0
Pharmacology & Pharmacy	51.0	1.35	14.1	1.5
Cell Biology	50.8	0.89	7.2	0.0
Hematology	45.2	1.03	8.3	0.0
Clinical Neurology	42.0	1.65	14.3	2.5

(Table 9 continued)

University, subject field	Publications per year	Mean citation rate	Prop. top 10%	Prop. top 1%
Medicine, General & Internal	40.9	2.50	11.6	1.3
Obstetrics & Gynecology	39.1	1.27	9.2	0.3
Surgery	38.4	1.75	10.9	1.8
Urology & Nephrology	37.6	1.25	9.2	1.6
Pediatrics	35.5	1.06	5.8	0.9
Psychiatry	35.1	1.09	7.5	0.6
Cardiac & Cardiovascular System	33.2	1.01	6.6	0.3
Genetics & Heredity	33.0	1.24	10.1	1.2
Gastroenterology & Hepatology	32.6	1.26	11.1	0.3
Physiology	32.4	0.95	9.6	0.0
Medicine, Research & Experimental	29.5	1.20	8.5	0.1
Peripheral Vascular Disease	28.9	1.09	6.5	0.1
Infectious Diseases	26.9	0.92	5.7	0.0
Rheumatology	26.0	2.08	23.6	1.2
Anesthesiology	25.6	1.35	4.7	0.8
Radiology, Nuclear Med. & Med. Imaging	23.3	0.83	5.8	0.6
Microbiology	22.3	1.16	8.6	1.1
Biophysics	21.7	1.19	11.6	1.8
Nutrition & Dietetics	21.4	1.47	13.8	1.0
Dentistry, Oral Surgery & Medicine	21.1	1.19	8.9	0.0
Linköping University				
Oncology	20.1	0.68	5.6	0.2
Biochemistry & Molecular Biology	20.1	0.65	3.7	0.0
Lund University				
Biochemistry & Molecular Biology	71.4	0.81	4.6	0.5
Endocrinology & Metabolism	52.3	0.99	8.3	0.7
Oncology	49.3	0.85	6.1	0.5
Neurosciences	41.5	1.11	6.9	1.7
Public, Environmental & Occupat. Health	38.6	0.79	3.7	0.3
Immunology	36.8	0.73	5.8	0.3
Hematology	33.4	0.87	4.3	0.2
Biotechnology & Applied Microbiology	32.5	0.89	3.8	0.3
Surgery	31.1	1.39	10.2	0.1
Cell Biology	27.6	0.73	5.0	0.8
Rheumatology	27.4	1.57	15.0	1.0
Obstetrics & Gynecology	27.2	1.01	3.8	0.2
Pharmacology & Pharmacy	25.1	1.31	10.5	3.8
Orthopedics	24.2	1.25	5.8	0.3
Peripheral Vascular Disease	23.9	0.87	2.0	0.0
Urology & Nephrology	22.3	0.97	4.5	0.0
Cardiac & Cardiovascular System	22.0	0.76	3.5	0.2
Biochemical Research Methods	21.7	0.91	6.4	0.0
Genetics & Heredity	21.5	0.79	4.6	0.2
Clinical Neurology	21.0	1.46	9.8	1.7
Radiology, Nuclear Med. & Med. Imaging	20.8	0.68	3.3	0.0
Physiology	20.5	0.77	10.1	0.6

(Table 9 continued)

University, subject field	Publications per year	Mean citation rate	Prop. top 10%	Prop. top 1%
Umeå University				
Biochemistry & Molecular Biology	32.4	0.87	6.6	0.0
Oncology	23.4	0.82	5.1	0.0
Public, Environmental & Occupat. Health	21.1	0.75	2.9	0.4
Uppsala University				
Biochemistry & Molecular Biology	86.9	0.77	5.0	0.1
Pharmacology & Pharmacy	44.8	1.22	8.1	1.3
Oncology	44.7	0.79	6.7	0.2
Endocrinology & Metabolism	30.5	1.05	7.7	0.5
Neurosciences	29.1	0.77	4.5	0.2
Genetics & Heredity	27.7	1.13	9.5	0.4
Cell Biology	27.2	0.79	6.8	0.0
Biochemical Research Methods	22.0	1.38	19.8	0.9
Immunology	20.3	0.59	3.4	0.0
Medicine, General & Internal	20.2	1.71	9.2	0.3

4.3 International cooperation

In many fields the proportion of scientific publications produced by international networks is increasing. Figure 13 shows some evidence of this for Finnish and Swedish medical publications. The internationalisation of clinical medicine has been stronger than that of biomedicine; currently there are more addresses, authors and countries on clinical publications than biomedical. Publications from Finland have more authors, addresses and countries than the Swedish publications.

It is well known that publications based on international cooperation, on average, are more highly cited. In table 10 the effect of international cooperation for publications in biomedicine and clinical medicine from Finland and Sweden are presented. The difference between national and international publications is larger for clinical medicine than for biomedicine.

Table 11 displays the countries that produce the largest number of joint papers (based whole counts) with Finland and Sweden respectively. The pattern from Table 11 is confirmed, with a larger effect of international cooperation for clinical medicine than for biomedicine. For both Finland and Sweden the most highly cited publications are those in clinical medicine produced involving cooperation with France and Canada. Finnish cooperation with Norway is also cited more than three times more often than the world average. Finally, it should be noted that many highly cited, international, publications is the result of large international networks involving many countries.

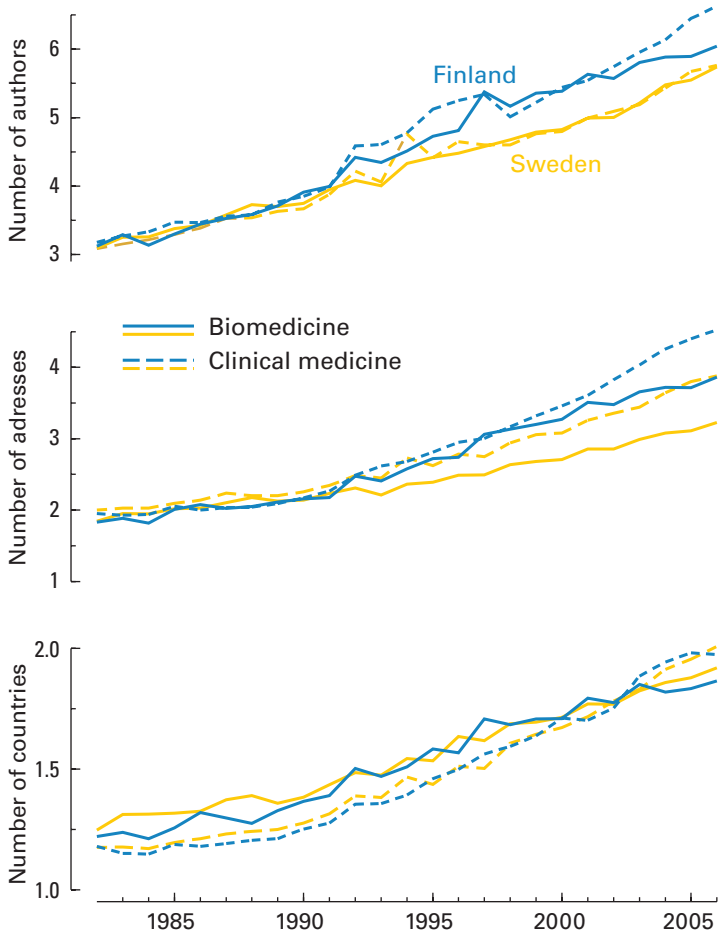

Figure 13. Some indices of the degree of cooperation behind the publication; number of authors, number of addresses and number of countries represented by the authors.

Table 10. Mean field normalised citation rate and proportion of highly cited (top 10%) publications in biomedicine and clinical medicine. International publications, i.e. those where the authors represent at least 2 countries, are included. Based on publications for 2004–2006.

Country / Field	National publications			International publications		
	Citation rate	Prop. top 10%	Prop cit. to top 10% [A]	Citation rate	Prop. top 10%	Prop cit. to top 10% [A]
Finland						
Biomedicine	0.75	5.3	27.5	0.97	6.3	31.4
Clinical medicine	0.90	8.3	37.5	1.44	8.2	45.9
Sweden						
Biomedicine	0.86	5.1	29.3	1.11	5.9	37.3
Clinical medicine	0.96	11.4	48.6	1.39	10.8	50.0

[A] The proportion of all field normalised citations received by the top 10% publications in respective group.

Table 11. Volume (number of whole count publications), field normalised citation rate and proportion highly cited (among top 10%) papers. The countries with the largest number of joint papers (calculated using whole counts) with Finland and Sweden respectively have been included. Based on publications for 2004–2006.

Country	Biomedicine			Clinical medicine		
	Number of publ.	Citation rate	Proportion top 10%	Number of publ.	Citation rate	Proportion top 10%
Finland						
USA	741	1.23	11.1	978	2.49	18.8
Sweden	450	1.23	9.3	835	2.53	19.8
UK	376	1.27	11.4	719	2.42	19.3
Germany	420	1.22	11.9	440	2.55	19.8
Netherlands	168	1.17	8.9	360	2.74	21.4
Italy	157	1.20	10.2	336	2.76	21.1
France	196	1.42	13.8	311	3.23	24.1
Denmark	134	1.04	9.7	367	2.96	21.5
Norway	106	1.12	11.3	358	3.08	22.1
Canada	131	1.56	13.0	213	3.05	27.2
Sweden						
USA	2009	1.60	13.3	2073	2.36	18.1
UK	1014	1.77	13.2	1452	2.46	20.2
Germany	968	1.36	11.3	1124	2.17	18.8
Denmark	565	1.35	10.4	1043	2.10	16.9
Finland	450	1.23	9.3	835	2.53	19.8
Italy	469	1.20	9.4	762	2.43	19.3
France	533	1.50	13.1	705	3.03	23.3
Norway	299	1.02	7.7	859	2.13	13.7
Netherlands	382	1.35	12.6	716	2.83	23.7
Canada	348	1.58	14.7	490	3.25	25.3

5 References

Adams, J. 2005. Early citations counts correlate with accumulated impact. *Scientometrics* 63: 567–581.

Aksnes D.W. 2005. Citation rates and perceptions of scientific contribution. *J. American Soc for Information Sci and Thechnol.* 57: 169–185.

Case D.O., Higgins G.M. 2000. How can we investigare citation behavior? A study of reasons for citing literature in communication. *J. American Soc. for Information Science* 51: 635–645.

Glänzel W. & Garfield E. 2004. The myth of delayed recognition. *The Scientist* 18: 8.

Leeuwen T.N. van, Visser M.S., Moed H.F., Nederhoof T.J. & van Raan AFJ. 2003. The Holy Grail of science policy: Exploring and combining bibliometric tools in search of scientific excellence. *Scientometrics* 57: 257–280.

Moed H.F.l 2005. Citation analysis in research evaluation. Springer, Dordrecht.

Wallin J.A. 2005. Bibliometric methods: pitfalls and possibilities. *Basic & Clinical Pharamacaology and Toxicology* 97: 261–275.

Vetenskaprådet 2006. *Hur mycket citeras svenska publikationer? Bibliometrisk översikt över Sveriges vetenskapliga publicering mellan 1982 och 2004*. Vetenskapsrådets rapportserie 13:2006.

Appendix 1

Annual publication volume and mean field normalised citation rates for all subject fields. Citation rates are only given when volume exceeds 20 publications per year. Based on publications for 2004–2006.

Subject field	Volume			Citation rate	
	all countries	Finland	Sweden	Finland	Sweden
Allergy	1155	15.2	33.1	-	1.12
Anatomy & Morphology	936	1.9	6.5	-	-
Andrology	308	1.7	8.4	-	-
Anesthesiology	3998	53.3	66.7	1.61	1.53
Biochemical Research Methods	5003	39.1	110.5	0.68	1.05
Biochemistry & Molecular Biology	32779	184.1	491.4	0.77	0.96
Biophysics	5586	34.0	94.7	1.14	1.09
Biotechnology & Applied Microbiology	8748	62.2	117.9	0.91	0.97
Cardiac & Cardiovascular System	10390	67.1	138.0	1.06	1.07
Cell Biology	12573	69.1	161.8	0.80	0.77
Chemistry, Medicinal	3883	17.9	33.9	-	1.29
Clinical Neurology	10917	96.0	151.0	1.34	1.43
Critical Care Medicine	2318	14.3	31.6	-	1.12
Dentistry, Oral Surgery & Medicine	4553	60.6	149.9	1.06	1.32
Dermatology	5011	20.5	61.4	1.14	1.52
Emergency Medicine	1535	5.2	7.7	-	-
Endocrinology & Metabolism	10409	146.4	270.5	1.13	1.06
Gastroenterology & Hepatology	7729	45.4	118.0	1.03	1.07
Genetics & Heredity	9499	85.3	133.6	0.83	0.98
Geriatrics & Gerontology	1685	24.4	33.7	1.04	0.97
Gerontology	937	6.8	12.7	-	-
Health Care Sciences & Services	2070	17.7	40.4	-	0.76
Hematology	7237	37.6	127.2	0.92	0.88
Immunology	11219	72.8	228.8	0.75	0.74
Infectious Diseases	5233	34.1	89.1	0.92	0.81
Integrative & Complementary Medicine	536	0.8	3.2	-	-
Medical Ethics	119	0.5	1.2	-	-
Medical Informatics	472	3.7	8.5	-	-
Medical Laboratory Technology	2067	18.0	26.3	-	1.75
Medicine, General & Internal	17092	65.8	141.6	1.94	1.91
MEDICINE, LEGAL	789	6.8	8.7	-	-
Medicine, Research & Experimental	6512	36.4	89.2	0.71	0.92
Microbiology	9998	74.8	144.4	0.79	1.03
Microscopy	647	1.5	9.3	-	-
Neuroimaging	633	7.9	4.5	-	-
Neurosciences	18822	140.7	278.2	0.78	0.95
Nursing	2100	20.2	79.4	0.90	1.13
Nutrition & Dietetics	4220	49.1	74.9	1.10	1.16
Obstetrics & Gynecology	6043	58.1	136.1	1.27	1.19
Oncology	18024	133.5	329.7	0.83	0.85
Ophthalmology	6352	32.5	64.4	0.84	0.83
Orthopedics	3949	34.5	90.3	1.45	1.22

(App. 1 continued)

Subject field	Volume			Citation rate	
	all countries	Finland	Sweden	Finland	Sweden
Parasitiology	2007	13.3	17.4	-	-
Pathology	4344	35.0	38.8	1.28	1.08
Pediatrics	7621	67.1	126.6	1.14	1.13
Peripheral Vascular Disease	5383	50.7	108.0	0.94	0.93
Pharmacology & Pharmacy	17137	116.0	219.0	1.13	1.22
Physiology	5292	29.3	107.7	0.77	0.81
Psychiatry	7143	81.6	117.1	0.90	0.86
Psychology, Clinical	2870	9.5	32.7	-	1.00
Public, Environmental & Occupational Health	8957	119.4	268.3	0.98	0.86
Radiology, Nuclear Medicine & Medical Imaging	9264	62.6	102.6	0.83	0.84
Rehabilitation	2062	15.0	63.4	-	1.07
Respiratory System	4269	22.8	66.7	1.04	1.18
Rheumatology	3671	55.2	92.2	0.80	1.84
Substance Abuse	1338	18.7	25.2	-	0.92
Surgery	15358	80.7	162.9	1.12	1.33
Toxicology	4014	32.5	66.7	1.10	1.21
Transplantation	1957	12.3	31.9	-	1.09
Tropical Medicine	857	0.5	5.7	-	-
Urology & Nephrology	8180	33.3	120.4	0.97	1.03
Virology	4067	29.2	52.0	0.78	0.80

In 2008, the Scientific Council for Medicine of the Swedish Research Council and the Research Council of Health of the Academy of Finland initiated an evaluation of the status of clinical research in Sweden and Finland. The study was conducted in November 2008–March 2009 by an international panel of senior clinical scientists.

The aim of the evaluation was primarily to obtain an objective expert opinion on the status of clinical research in both countries, and to reveal any current trends in the quantity and quality of clinical research in a global perspective.

This report presents the results of the evaluation of clinical medical research carried out in Finland and Sweden. The report also includes proposals for future development of research in the field.

Vetenskapsrådet

ACADEMY OF FINLAND

Vilhonvuorenkatu 6 • PO Box 99, 00501 Helsinki
Tel. +358 9 774 881 • Fax +358 9 7748 8299
www.aka.fi/eng • viestinta@aka.fi