Nordic Potential in Medical Research – Cooperation for Success

Nordic White Paper on Medical Research

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The Joint Committee of the
Nordic Medical Research Councils

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NOS-M is grateful to all past and present members of the national Research Councils, the NOS-M secretariat at NordForsk, and external who have contributed to this paper (Appendix 1), the Nordic Institute for Studies in Innovation, Research and Education (NIFU) and the Centre for Science and Technology Studies, Leiden University (CWTS B.V.) for bibliometric and statistical data. The valuable contribution of Science Writer Simon Hadlington is also acknowledged.

The Joint Committee of the Nordic Medical Research Councils, NOS-M
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Executive Summary

In 2011 NOS-M (Box 1) presented the White Paper *Present Status and Future Potential for Medical Research in the Nordic Countries* [1], which highlighted actions that are needed in the Nordic region to maintain a competitive position globally and respond to the scientific, healthcare and economic 'Grand Challenges' facing today's society. The aim of the present updated White Paper is to advance the discussion on the added value of Nordic cooperation in medical research and to recommend concrete actions that need to be taken.

The Nordic countries have enormous potential for success in medical research. We have succeeded in combining equality of education and elitism in a unique and successful Nordic model as evident by the outstanding number of top universities in the region and competitive publication and citation scores in the field. In the future, however, joint efforts will be necessary to ensure that the Nordic region becomes a unique area for medical research, attractive to international top-level researchers, industry and investors. In order to take full advantage of our potential, strong strategic cooperation and coordination is crucial.

In this paper **biobanks and registers** and **personalised medicine** are identified as areas where the Nordic countries through cooperation have an opportunity to become world leaders. Focus, however, needs to be set on **improving medical researchers´ career opportunities** as well as on **cooperation and investment in basic research,** which remains fundamental for success in clinical applied research.

Since 2011 the landscape for strategic cooperation among the European medical science policy actors has changed profoundly due to the termination of the European Medical Research Councils (EMRC) in 2013. This leaves the Nordics in an exclusive position, being the only European region that already has a comprehensive common strategic network of national medical research councils, NOS-M. With this White Paper NOS-M strives to continue the important work of EMRC from a Nordic perspective, highlighting the possibilities of Nordic cooperation and the importance of a common strategic agenda in medical research. Further, NOS-M wishes to impact both European and global policy actions aimed at promoting medical research.

Box 1

The Joint Committee of the Nordic Medical Research Councils (NOS-M) is a collaborating body for the Nordic Research Councils that finance medical research. NOS-M serves as a forum for important information exchange on national research policies, funding and development. www.nos-m.org

NordForsk is an organisation under the Nordic Council of Ministers that provides funding for Nordic research cooperation as well as advice and input on Nordic research policy. NordForsk works to enhance existing research activities in the Nordic countries, and thereby strengthen the position and influence of Nordic research, both in Europe and globally. The organisation launches strategic initiatives, which bring together national research groups in large-scale Nordic programmes based on the common pot principle. NordForsk has held the secretariat function for NOS-M since 2013. www.nordforsk.org

Science Europe (SE) is an association of European research funding organisations and research performing organisations that promotes the collective interests of these organisations. Within SE there are several Science Committees, including the Medical Sciences Committee (SE-MED). www.scienceeurope.org

1. Introduction

Aurora Borealis, Iceland. Photo: Daniel Schreiber/Shutterstock

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1. Introduction

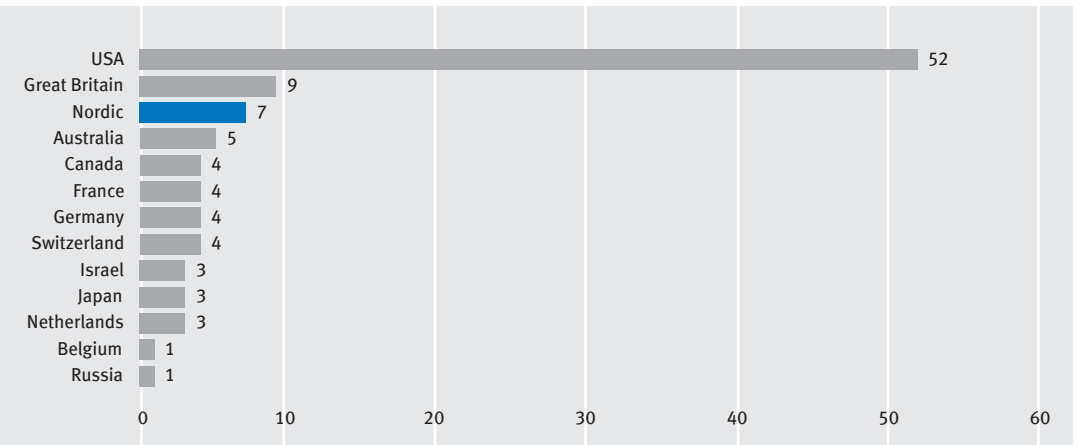
In 2011 NOS-M presented a White Paper [1] that identified and analysed opportunities for strengthening medical research jointly and individually among the Nordic countries. The paper highlighted those actions that are needed in the region to maintain a competitive position globally and respond to the scientific, healthcare and economic 'Grand Challenges' facing today's society. It was concluded that within medical research, Nordic cooperation towards common strategic goals could provide an opportunity to shape the region into a competitive environment for top-level research, attracting international researchers and investors. By working together, the Nordics are strong enough to be a leading force in international medical research, with a great opportunity to influence, build and lead the common European Research Area (ERA). Better incentives for Nordic cooperation are, however, needed.

In 2011 NOS-M stressed the fact that basic and clinical research require increased attention as the quality and quantity of clinical research is threatened in the Nordic countries. High quality clinical research is essential in order to improve the quality and cost-efficiency of the healthcare system, whereas investigator-driven basic research is crucial as an important foundation for more applied science. Faith and trust in basic research should thus be the key issue in medical research policy. In addition better integration of medical faculties and university hospitals and focus on the clinical researcher's career are essential.

Since the publication of the NOS-M White Paper in 2011 there has been a significant change in the premise for strategic European coordination in medical research with the termination in 2013 of the European Medical Research Councils (EMRC). This has left the European medical research community without a strong common forum for discussing science policy and implementing common strategies. In this new situation, the Nordic region is in a unique position as we already have a functioning common science policy forum, NOS-M, and an organisation facilitating the funding and implementation of common initiatives, NordForsk. NOS-M will now step up to meet the new demands to fill this void and actively search for new opportunities and means to strengthen Nordic medical research through strategic cooperation and coordination. NOS-M will also continue the important cooperation with EMRC's successor, the Medical Sciences Committee within Science Europe (SE-MED), as well as with NordForsk (Box 1).

The aim of the present updated version of the Nordic White Paper is to bring the discussion on the future potential of medical research in the Nordic countries to a new level. The Nordics have enormous potential for synergy if we can take advantage of our similarities. We have the same socio-economic background, strong healthcare registers and biobanks, publicly owned universities and university

Figure 1. Distribution of the 100 Best Universities in the World, 2013.
Source: Shanghai 2013 University Ranking, Appendix 2.



hospitals and a high appreciation for medical research among the general public and politicians. This policy paper also aims to identify specific areas within medical research where cooperation between the Nordic countries could achieve significant added value through major scientific advances, new innovations and investments. The paper makes recommendations for actions needed to take full advantage of this potential.

Individually, the Nordic countries are small, but combining data, resources and the knowledge base opens new possibilities [2]. With 26 million inhabitants, the Nordics form a noteworthy fraction of the European population and our common Gross domestic product (GDP) of over 1100 billion Euros is among the highest in the world. Further, seven of the 100 best universities in the world are found in the Nordic countries according to the Shanghai 2013 University Ranking (Fig. 1, Appendix 2); the only countries in the world with more top universities are the USA and Great Britain. Taken together, the Nordic region has more top universities than Germany or France. The unique Nordic model combining equality of education and elitism could be a key factor in the success of Nordic universities.

The outstanding potential of Nordic cooperation has previously been recognised by various bodies. The Svalbard Document [3], published in 2012 by among others the Association of Nordic University Rectors Conferences (NUS), gives an insightful and encouraging view of the strengths of a united Nordic region and our future potential (Box 2).

Box 2

The Svalbard Document
Main conclusions from a meeting between the Research Committee of the Norwegian Association of Higher Education Institutions and representatives from EUA and the Association of Nordic University Rectors Conferences (NUS) Longyearbyen, 20–22 April 2012.

The Nordic Dimension as a Stepping Stone to Europe
It is time for the Nordic universities and university colleges to work closer together. Close cooperation between Nordic higher education institutions is of high value not least as a stepping stone to the European Research Area and the rest of the world. The Nordic knowledge sector as a whole is larger than the sum of its parts:

- Together we are more interesting as partners
- Together we are stronger
- Together we have more impact on the world

Strengths that we share
Although the Nordic countries are different, similarities regarding the region's basis for an outstanding knowledge sector are striking:

a) We are *Excellent*: Probably the best region in the world: The Nordic region (24 million) has seven universities among the Shanghai top 100 universities.

b) We are *Innovative*: The Nordic countries form probably the most innovative region in the world, relative to its size.

c) We are *Dynamic*: The Nordic universities are modernising their institutions and learning from each other.

d) We are *Cooperative*: Active, constructive and supportive partner in building ERA and promoting EU research. Also Nordic common pot: Top-level Research Initiative (TRI) – on climate, energy and the environment.

e) We are *Sustainable, Inclusive and Secure.* Due to the Nordic welfare model all Nordic countries are sustainable, inclusive and secure.

2. Medical Research in the Nordic Countries – Financial Input and Academic Output

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2. Medical Research in the Nordic Countries – Financial Input and Academic Output

Medical research has traditionally been seen as a priority in the Nordic countries. Figures from the OECD (2011) show that the common GDP per capita is high in the Nordics as compared to the biggest European economies and the USA (Fig. 2). In addition, the Nordic countries spend more than many other countries on medical research both in terms of total expenditure and the contribution from the public sector (Fig. 3).

Figure 2. GDP in Euros per Capita in Selected Countries in 2011.
Source: OECD, NIFU, Appendix 3.

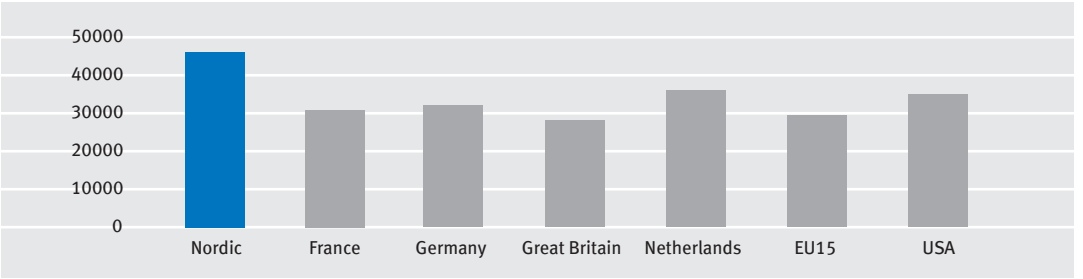
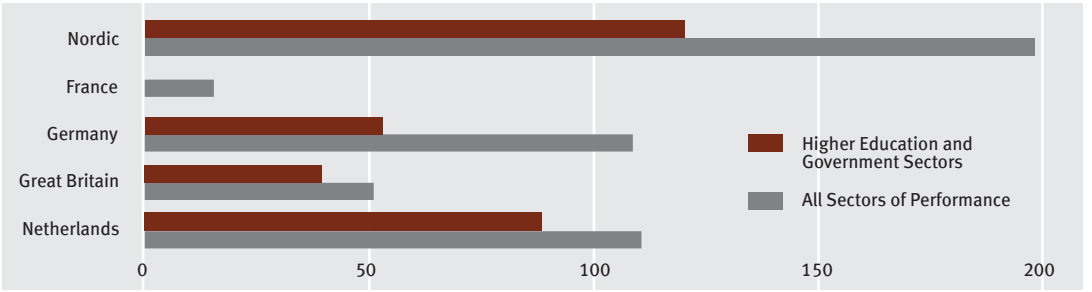


Figure 3. Expenditure for Research and Experimental Development (R&D) in the Medical Sciences in 2011 in Euros per Capita. All sectors of performance, including Business enterprise, Private-non-profit, Higher education and Government sectors, indicated in grey, and total of Higher education and Government sectors in brown. France does not report the numbers for medical sciences separately in the Higher Education and Government sectors. Source: OECD, NIFU.
See also Appendix 3.



To estimate the long-term outcomes of medical research is a challenging task, but a proxy for academic output is the production of scientific papers measured with bibliometric tools. Productivity measured as number of medical publications per capita is very high in the Nordic region compared to the rest of Europe and to the USA (Fig. 4A). However, when measuring the number of medical publications against GDP (Fig. 4B) the Nordic position is not quite as prominent.

Figure 4. Production of Medical Publications
A) per Million Inhabitants and
B) per GDP in Billion Euros.
Mean number of medical publications per year 2010-2012.
Source: OECD, NIFU and CWTS B.V.See also Appendices 3 and 4 (Certain CWTS data included herein are derived from the ©Web of Knowledge of Thomson Reuters LLC. All rights reserved).

Figure 4A. Number of Medical Publications/M inhabitants

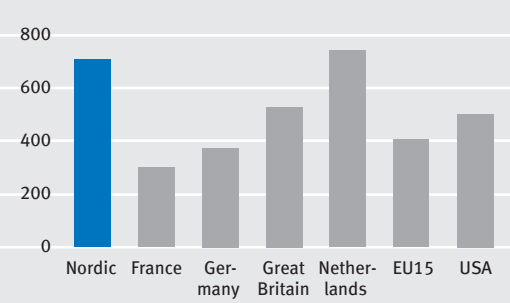
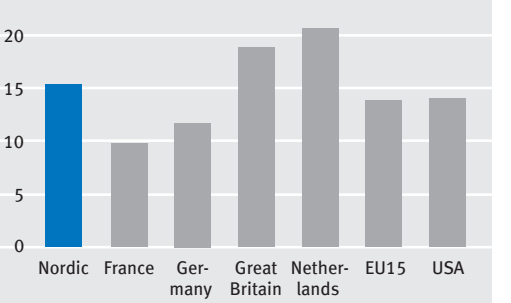


Figure 4B. Number of Medical Publications/billion GDP



When studying the rate of production of medical publications since 1993 (Figs 5 and 6), a general increase in the number of publications per year is observed both in the Nordic countries and at a global level. The Nordic growth rate has, however, been more modest compared to the development globally as a decrease in the Nordic share of world medical publications from 4.7 % in 1994 to 3.6 % in 2011 is apparent (Fig. 5C).

Figure 5: Total Amount of Medical Publications in the Nordic Countries and the World per Year in 1993–2011 (moving three-year averages, the middle year of the time frame presented).
A) Total number of medical publications per year.
B) Relative amount of medical publications per year, the three-year average for each category in 1993–1995 set as 100 %.
C) The Nordic share of total world medical publications.
Source: CWTS B.V. See also Appendix 4 (Certain CWTS data included herein are derived from the © Web of Knowledge of Thomson Reuters LLC. All rights reserved).

Figure 5A. Number of Medical Publications per Year

Year	Nordic	World
1994	13 218	283 400
1995	13 645	295 313
1996	13 993	304 807
1997	14 198	312 541
1998	14 403	319 083
1999	14 422	325 158
2000	14 456	328 084
2001	14 297	330 587
2002	14 269	335 351
2003	14 310	345 305
2004	14 641	359 038
2005	15 087	375 536
2006	15 551	396 475
2007	16 068	421 637
2008	16 470	445 282
2009	16 997	466 453
2010	17 495	485 184
2011	18 086	505 095

Figure 5B. Relative Amount of Medical Publications

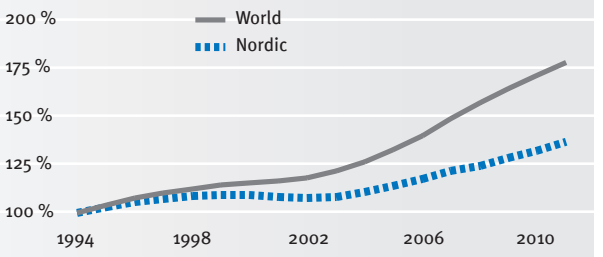
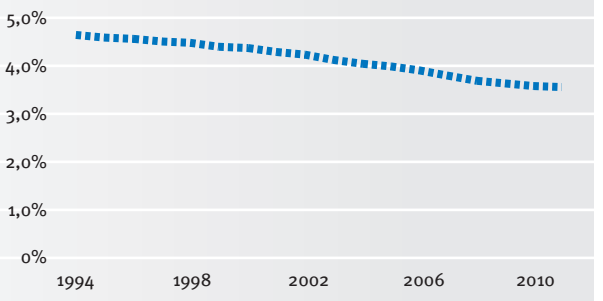
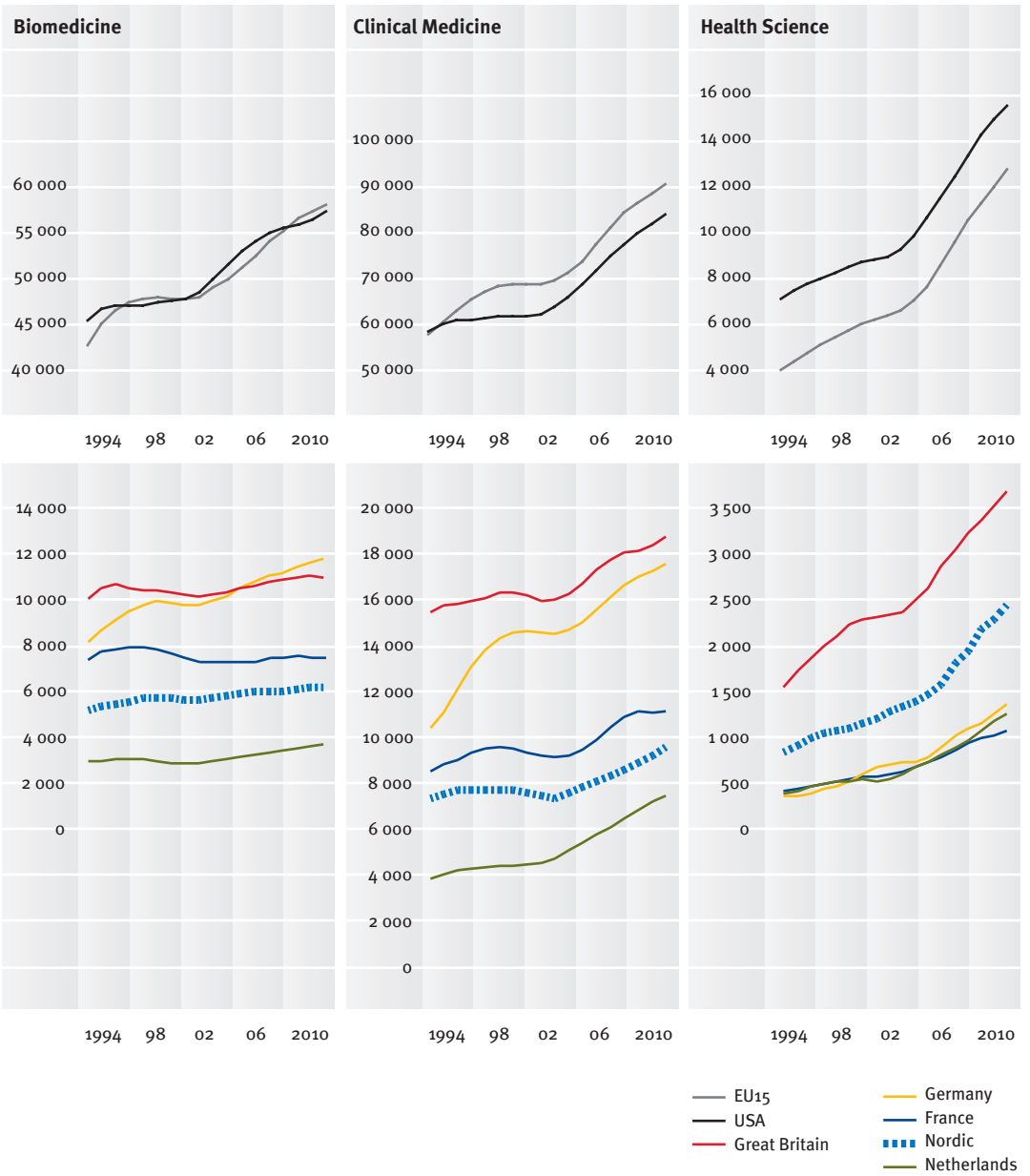


Figure 5C. Nordic Share of World Medical Publications



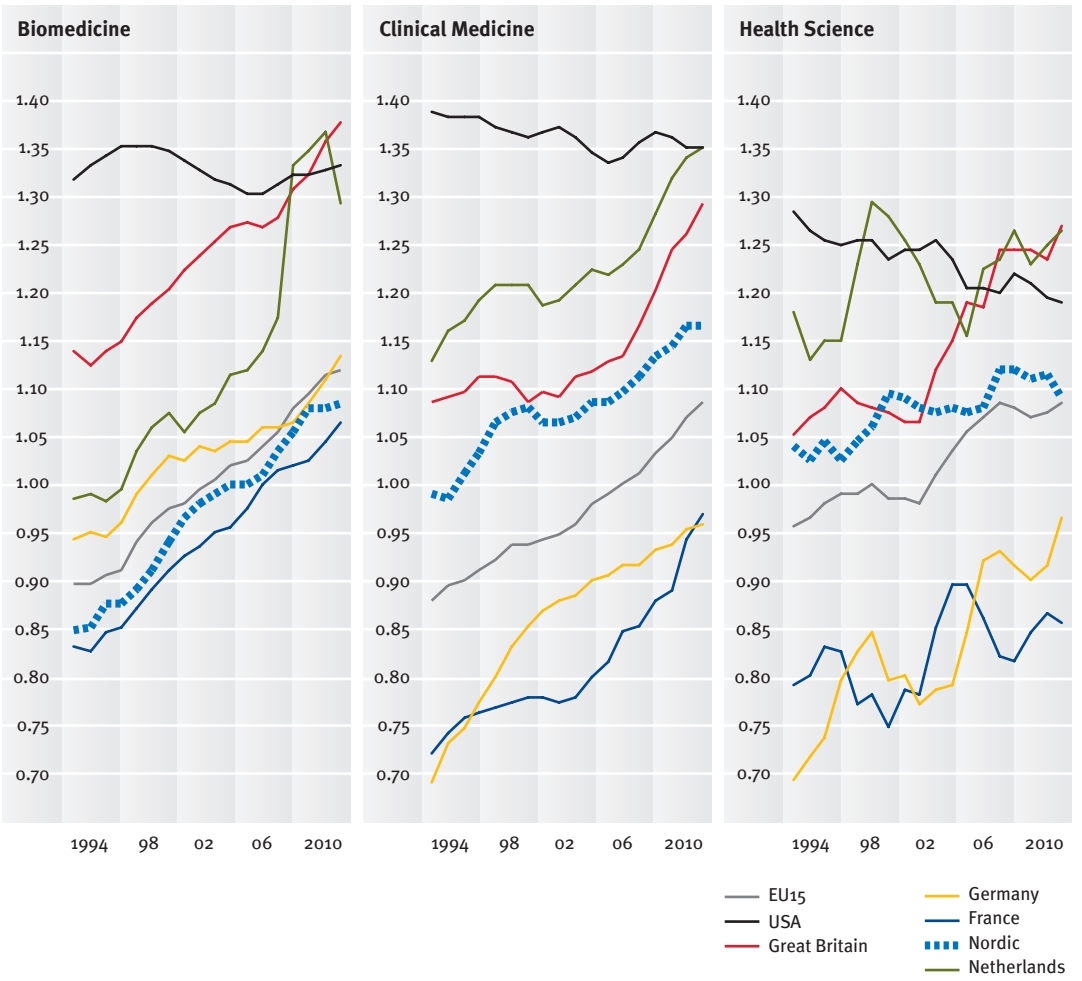
When breaking down the medical publications in three sub-fields, biomedicine, clinical medicine and health sciences (Fig. 6, Appendix 4), the Nordic trend in all three fields roughly seems to follow a similar development to that seen in the USA and EU15. The publication volume of the Nordics is the fourth largest in Europe in biomedicine and clinical medicine, whereas we come second in health sciences.

Figure 6: Number of Publications in Biomedicine, Clinical Medicine, and Health Science in 1993–2011 (moving three-year averages, the middle year of the time frame presented).
Source: CWTS B.V. Appendix 4 (Certain CWTS data included herein are derived from the ©Web of Knowledge of Thomson Reuters LLC. All rights reserved).



The mean normalised citation scores (MNCS; Fig. 7) provide a rough measure of the scientific impact and quality of research. The Nordic citation score shows an upwards trend in biomedicine, as well as in clinical medicine and health sciences. This increase is comparable to that seen generally across Europe, whereas the profile for the USA seems more modest. Even though Great Britain and the Netherlands show the best European citation scores in all three fields the Nordic scores nevertheless remain very competitive.

Figure 7: Mean Normalised Citation Score (MNCS) in Biomedicine, Clinical Research and Health Science in 1993-2000 (moving three-year averages, the middle year of the time frame presented).
Source: CWTS B.V. Appendix 4 (Certain CWTS data included herein are derived from the ©Web of Knowledge of Thomson Reuters LLC. All rights reserved).



In conclusion, the statistical analyses show that the Nordics together invest considerably in medical research. The bibliometric analyses further show that these investments are reflected in a solid scientific output and that collectively the Nordic countries are a major actor in the European medical research field, which makes us a tempting region for others to invest in.

The Nordic trend is positive both with respect to the quantity and the quality of scientific output. In comparison with other European countries as well as with the USA we display high standards, even though the Nordic share of total world medical publications is decreasing. Together we have great potential and through intensified collaboration we could improve our scientific output even further. The many synergistic factors in combination with the significant financial investments in medical research in the Nordic region form an exceptional foundation for common success that we should use to the best possible advantage.

3. Nordic Potential

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3. Nordic Potential

Analysing the present status of medical research in the Nordic countries and comparing national areas of interest and visions for the future, NOS-M has identified three specific areas where coordinated actions and determined cooperation could bring the Nordic region into a unique, world-leading position. In the context of these themes it is, however, important to highlight the crucial role of basic research as a pre-requisite for all innovations. The importance of basic research as the fundamental basis for applied and clinical research was discussed in NOS-M´s previous White Paper [1] and remains a key issue.

i. Biobanks and registers

The Nordic countries have been pioneers in establishing population-based biobanks. Specific Nordic assets such as the personal identification number, national healthcare system, registers defining genetically informative populations and health outcomes make the Nordics uniquely suited for a successful biobanking infrastructure.

Initiatives in this area have already been made as the Nordic countries have allocated significant funding for establishing national research infrastructures on biobanks, which will allow scientists to share and couple data from different biobank resources nationally [4]. Further, in 2011 a collaborative network between national Nordic biobanking infrastructures, the Nordic Biobank Network, was formed (Box 3). The aim of this network is to exchange experiences and techniques among the Nordic countries to harmonise procedures to enable large international studies that include data from all Nordic countries. The network also aims at influencing European standards for international cooperation on biobanking and will serve as an important Nordic link to European biobanks.

Box 3

Nordic Networks
The Nordic initiative **Nordic Biobank Network** (previously BBMRI Nordic) is a collaborative network between national biobanking infrastructures in the Nordic countries. In 2012, NordForsk funded a pilot project on colon cancer run by this network that aims to prove that large-scale biobank sciences can be carried out across borders. In this project, scientists within the Nordic region will be sharing information and infrastructure through a common biobank registry in order to enhance knowledge about the causes of colorectal cancer.
www.bbmri.se/en/About-us/International-Work/BBMRI-Nordic/

The Nordic Trial Alliance (NTA) is a pilot project funded by the Nordic Council of Ministers and NordForsk between 2013–16 with the aim to enhance Nordic cooperation on clinical multi-centre trials and overall to make it easier to carry out clinical research in the Nordic region. This will lead to a rise in the number of joint clinical trials and thus boost the attractiveness of the Nordic countries as partners in research for commercial pharmaceutical companies. Such activities will promote knowledge transfer as well as increased efficiency and research output and assist the Nordic pharmaceutical industry. A further vision is that more clinical studies in the Nordic region will give the population faster access to new treatment methods and medicines.

The Nordic Trial Alliance is based on established national networks for clinical research, and will lay the foundation for increased collaboration between national and Nordic stakeholders. www.nta.nordforsk.org

Another important action already taken by NordForsk is the appointment of the NORIA-net on Registers and Biobanks, a working group that aims to strengthen Nordic cooperation in register-based research. In its final report the working group presents an action plan stressing the importance of simplifying Nordic research support operations carried out by different actors. Support should also be given to the approximation of Nordic legislation and practices for using personal data in cross-border research as well as the development of technical solutions to enable secure transfer, storage and access to research data across borders [5]. NOS-M strongly supports these recommendations and their introduction at a political level. NordForsk will continue its work to facilitate cross-border use of Nordic research infrastructures and plans to support the establishment of joint Nordic research infrastructures such as registers.

The existing national and Nordic investments in research infrastructures, in combination with the planned prioritisations by national and Nordic actors and the high standards of the Nordic healthcare systems, provide us with unique opportunities for high quality medical research. This, however, requires excellent research infrastructures also for analysing the patient data stored in the biobanks and registers. As such top-quality research infrastructures, including sophisticated equipment and labs, are often very expensive, the Nordic countries could benefit both from sharing existing infrastructures and from joint new investments. Combining the Nordic strengths will give researchers the possibility to answer new complex questions with implications for human health and wellbeing globally. It is, however, important also to fund and cooperate within clinical research generally in order to produce clinical data that can be linked to register data to formulate valid conclusions and to raise new meaningful research questions. To take full advantage of this opportunity, strong strategic actions will be crucial and NOS-M highly recommends coordination of legislation, funding and strategies to support common Nordic goals. Within this area the Nordics have an excellent opportunity to pilot a common-pot funding model to achieve the best results possible.

ii. Personalised medicine

The concept of personalised medicine is predicted to dramatically improve the efficacy and safety of patient treatment and simultaneously reduce healthcare expenditure and minimise the use of unnecessary and inefficient treatments and drugs. As stated in the recent ESF Forward Look *Personalised Medicine for the European Citizen* [6] personalised medicine represents a shift from reactive medicine to proactive, pre-emptive and preventive healthcare.

The forthcoming introduction of personalised medicine will not only be a scientific and technological challenge but will also present a number of new ethical and legislative questions related to the use of personal data and prioritisation. It will require new forms of tight cross-disciplinary interactions between clinicians of different specialities as well as bioscientists and technologists, where each group must increase its knowledge and understanding of the others' professions. In particular, bioinformatics and biostatistics will become increasingly central to all aspects of healthcare. In addition the interaction between healthcare professionals and patients will change when decisions concerning the patient's health and possible treatments become more diversified, including questions concerning self-care and the possibility of patients to access and make use of their own health information. The specific demands of personalised medicine will further require attention to the education and training of all professionals involved. There will also be a growing demand for information to be easily available to all citizens, patient groups and decision makers.

The Nordic region is in an excellent position to take a leading role in the global introduction of personalised medicine as we have many systems and structures in place that would support such an endeavour. There are already efficient collaborating networks, such as the previously mentioned science policy, biobanking and data register networks as well as more clinically oriented networks, for example the Nordic Trial Alliance (NTA, Box 3). NTA strives towards a common Nordic research area that in addition to biobanks and registers also includes interventional research. This network may further enhance Nordic cooperation with the European clinical community through the European Clinical Research Infrastructures Network (ECRIN, www.ecrin.org).

Again the similar environmental variables in our countries (related to, for example, lifestyle, nutrition, environment and societal factors) in combination with our high quality healthcare system lay an exceptional foundation for pioneering consequential research on questions raised by the introduction of personalised medicine. However, coordinating actions need to be taken immediately if we wish to take advantage of the opportunities that will be presented. We need common Nordic initiatives, an approximation of legislation and procedures, and strategic investments to make the most of the synergistic potential that exists to reach a position in the forefront of developments in this field. The on-going revision of European data protection regulations and clinical trial directives will also impact joint Nordic efforts in this area.

In the ESF Forward Look *Personalised Medicine for the European Citizen* [6] a series of recommendations are presented under four core headings: (1) data handling, (2) models and decision-making processes, (3) interdisciplinarity and (4) infrastructure and resources (Appendix 5). NOS-M greatly stresses the importance of following up these recommendations at a Nordic level and of working towards their implementation in the Nordic healthcare system. Each country should focus on promoting funding for this topic and actively seek possibilities for joint Nordic efforts.

Box 4

NOS-M Recommendations for a Harmonisation of Nordic Medical PhD Education (2014)

NOS-M recommends that:

- All PhD students should have at least two supervisors.
- Clinical PhD students should be allowed to spend a minimum of 50 % of their time on research.
- PhD courses in the Nordic countries are
  i) available to PhD students in all Nordic countries;
  ii) coordinated to obtain critical mass in small and scattered research areas;
  iii) credited through the ECTS (European Credit Transfer and Accumulation System) and that ECTS credits are transferable between the Nordic countries.
  The definitions of ECTS in the PhD courses should be harmonised, e.g. 1 ECTS = 25–30 hours.
- A website announcing PhD courses held at Nordic medical and health science faculties is being set up. The website could build on an existing university course database and later be extended to also include European courses.
- PhD students are subjected to regular evaluation in order to monitor the progress of the PhD project and the accumulation of the PhD candidate's skills and knowledge (scientific writing, presentation techniques, teaching, project management, talks at conferences, innovation, etc.) as well as international mobility.
- The focus should be on quality and scientific impact of the PhD thesis rather than the number of original publications included. NOS-M recommends that the PhD thesis is based on peer reviewed scientific papers aimed for publication in international scientific journals. The PhD candidate should be the first author of at least one accepted scientific paper.
- PhD students are educated in open access practices for both data and publications.
- The importance of the candidate's summary [sammmenskrivning (NO), ramberättelse/kappa (SE), oversigt (DK), yhteenveto (FI), ritgerd (IS)] is emphasised.
- An international expert should be included in the doctoral committee/external reviewer panel or as an opponent.

iii. Researcher career opportunities

In the previous White Paper it was concluded that more incentives, supported by increased funding, are needed to strengthen the career opportunities of Nordic medical researchers. One important step in this endeavour would be a **harmonisation of Nordic medical PhD education**. This would greatly facilitate the opportunities for cooperation and exchange of both expertise and experience between the Nordic universities and would inevitably enhance the quality of education. This would also give PhD students better opportunities to increase their knowledge in specialised fields as the universities across the region have expertise in different specialisms. NOS-M has initiated a discussion with the deans of the Nordic medical faculties to support this development (Box 4).

Successful harmonisation of medical PhD education in the Nordic region would further support another important career incentive: mobility. A similar curriculum in combination with improved resources, especially flexible funding opportunities, would open great possibilities for enhanced **mobility** among researchers working in the Nordics. If researchers could move smoothly within the region to conduct their research wherever the best knowledge and infrastructure is available remarkable synergistic effects could be achieved. This would also increase the attractiveness of the Nordic region for foreign researchers and investors and attract the best Nordic young researchers back to their home region after visits abroad. Mobility should, however, also be supported in later career stages and the motive should always be to enhance the quality of research.

The above-mentioned improvements of career opportunities for medical researchers should be complemented with an increased focus on **gender equality**. Even though the Nordics have a reputation as world-leaders in implementing gender equality, only 23% of Nordic professors in medicine and health science are women whereas close to 60% of the doctoral degrees in these fields are completed by women [7]. Gender inequality can be seen especially in Centres of Excellence and other academic elite environments that are growing increasingly important and which for some reason seem to favour men [7]. Further, the increasing autonomy of universities introduces new challenges for addressing gender equality, as well as the growing focus on excellence and innovation.

NOS-M agrees with the Norwegian Committee for Gender Balance in Research (the KIF-committee) in recommending Nordic cooperation in promoting gender equality in research [7]. NOS-M further proposes that the medical research field could take a lead in the process of developing common Nordic guidelines on this topic. There are already many factors facilitating the implementation of such future guidelines, for example we have day-care systems of high standard, giving parents a unique opportunity to combine professional and family life. Nordic societies are also acknowledged for comprehending and accepting family leave as a concept that is not exclusive to mothers.

While the Nordic countries are pioneers in promoting equality, statistics show that we still have obstacles to overcome in order to enable women to participate on equal terms with men along the entire career path and ultimately to occupy the most senior positions [7]. If we are able to mobilise the best resources independent of gender, we will have a competitive advantage over those countries that remain further from reaching such a goal.

In conclusion, there are several important questions that need immediate attention to enhance the career opportunities of medical researchers in the Nordic region, the foundation of future success in medical research.

4. Conclusions

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4. Conclusions

Together the Nordic countries are a strong actor in medical research

The Nordic countries have succeeded in combining equality of education and elitism in a unique and successful way. Together we host seven of the 100 best universities in the world, a number exceeded only by the USA and Great Britain. Further, the Nordics invest considerably in medical research, including research infrastructures, and this investment is reflected in a level of high-quality scientific output that ranks the Nordic region as a major actor in the European medical research field, which in turn makes us a tempting region for others also to invest in. The developing trend of scientific output from the Nordic countries is positive in terms of both quantity and quality and in comparison with other European countries, as well as the USA, we hold high standards.

Significant added value can be achieved through cooperation

Together the Nordic countries produce an impressive output in medical research, but through intensified collaboration this could be further improved. There exists an exceptional opportunity to take advantage of the many synergistic factors that exist between the countries, together with significant financial investment in medical research and joint research infrastructures, that could form a strong foundation for common success. NOS-M has identified three specific areas where coordinated actions and determined cooperation could bring the Nordic region into a unique, world-leading position:
i) Biobanks and registers, ii) Personalised medicine, and **iii) Researcher career opportunities**. In all these fields the opportunities for success are excellent if we combine our strengths. As a united area for health research we will be very attractive for international researchers, research funding and investment for supporting innovative development.

Enhanced strategic cooperation is essential to realise the Nordic potential

To take full advantage of our potential, strong strategic cooperation and coordination among the Nordic countries is crucial. We should focus on the unique strengths of the Nordic societies and develop these further into innovations and investments. We already have a tradition of important and influential cooperation and through enhanced strategic cooperation the Nordics are strong enough to be a leading force in international medical research. Action needs to be taken immediately before we lose this position.

Recommendations

In the Nordic countries:

- Efforts should be extended to increase and improve cooperation in medical research and research policy to take full advantage of the valuable assets we already have and their inherent potential.

- Attention should be paid to removing obstacles for using Nordic research infrastructures such as biobanks and registers in joint Nordic research to make the best possible use of our unique resources and facilitate world-class research in this area.

- Each country should strive to implement the ESF recommendations on personalised medicine. Funding should be focused on this area, on-going initiatives should be supported and possibilities for cooperation should be investigated.

- Nordic medical PhD education should be harmonised to enhance the quality of education through synergistic effects of shared experiences and expertise. Further, researcher mobility should be supported at all career stages to increase quality of research.

- Gender equality should be supported by allowing all researchers to participate on equal terms at all stages along the career path up to the most senior positions.

To achieve these goals, the challenges that have been identified must be acknowledged at all levels of decision-making and must be taken into account during the preparation of research policies and budgets both at the national and the Nordic level.

References and Appendices

Shanghai 2013 World University Rankings:

42. University of Copenhagen, Denmark

44. Karolinska Institute, Sweden

69. University of Oslo, Norway

73. Uppsala University, Sweden

76. University of Helsinki, Finland

81. Aarhus University, Denmark

82. Stockholm University, Sweden

NOS-M

The Joint Committee of the
Nordic Medical Research Councils

References

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[3] The Svalbard Document.
http://www.uhr.no/documents/Svalbard_Document_20_22_april_2012.pdf

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[6] Personalised Medicine for the European Citizen. ESF Forward Look 2013.

[7] The Nordic Region – a step closer to gender balance in research?
Nordic Councils of Ministers 2013.

Appendices

Appendix 1: Members of the Joint Committee of the Nordic Medical Research Councils (NOS-M) 2014
Appendix 2: Shanghai 2013 World University Rankings
Appendix 3: Economic figures, NIFU
Appendix 4: Statistical information, CWTS B.V.
Appendix 5: ESF Forward Look *Personalised Medicine for the European Citizen*, recommendations

Appendix 1
Members of the Joint Committee of the Nordic Medical Research Councils (NOS-M) 2014

Professor Tuula Tamminen (Chair)
University of Tampere, Finland

Dr. Jona Freysdottir
Landspitali University Hospital, Iceland

Professor Jørgen Frøkiær
Aarhus University Hospital, Denmark

Professor Anne Husebekk
University of Tromsø and University Hospital North Norway, Norway

Professor Lars Køber
Rigshospitalet – Copenhagen University Hospital, Denmark

Professor Pauli Puolakkainen
University of Helsinki, Finland

Professor Stig Slørdahl
Norwegian University of Science and Technology, Norway

Professor Mats Ulfendahl
Secretary General, Medicine and Health, Swedish Research Council, Sweden

Professor Birgitta Öberg
Linköping University, Sweden

Administrative Representatives from:
Academy of Finland, Finland
Danish Council for Independent Research | Medical Sciences, Denmark
RANNÍS – The Icelandic Centre for Research, Iceland
Research Council of Norway, Norway
Swedish Research Council, Sweden
NOS-M Secretariat at NordForsk

Appendix 2
Shanghai 2013 World University Rankings
www.shanghairanking.com

Rank	Institution	Country
1	Harvard University	USA
2	Stanford University	USA
3	University of California, Berkeley	USA
4	Massachusetts Institute of Technology (MIT)	USA
5	University of Cambridge	UK
6	California Institute of Technology	USA
7	Princeton University	USA
8	Columbia University	USA
9	University of Chicago	USA
10	University of Oxford	UK
11	Yale University	USA
12	University of California, Los Angeles	USA
13	Cornell University	USA
14	University of California, San Diego	USA
15	University of Pennsylvania	USA
16	University of Washington	USA
17	The Johns Hopkins University	USA
18	University of California, San Francisco	USA
19	University of Wisconsin – Madison	USA
20	Swiss Federal Institute of Technology Zurich	CH
21	The University of Tokyo	JPN
21	University College London	UK
23	University of Michigan - Ann Arbor	USA
24	The Imperial College of Science, Technology and Medicine	UK
25	University of Illinois at Urbana-Champaign	USA
26	Kyoto University	JPN
27	New York University	USA
28	University of Toronto	CAN
29	University of Minnesota, Twin Cities	USA
30	Northwestern University	USA
31	Duke University	USA
32	Washington University in St. Louis	USA
33	University of Colorado at Boulder	USA
34	Rockefeller University	USA
35	University of California, Santa Barbara	USA
36	The University of Texas at Austin	USA
37	Pierre and Marie Curie University - Paris 6	FRA
38	University of Maryland, College Park	USA
39	University of Paris Sud (Paris 11)	FRA
40	University of British Columbia	CAN
41	The University of Manchester	UK
42	**University of Copenhagen**	**DEN**
43	University of North Carolina at Chapel Hill	USA
44	**Karolinska Institute**	**SWE**
45	University of California, Irvine	USA
46	The University of Texas Southwestern Medical Center at Dallas	USA
47	University of California, Davis	USA
47	University of Southern California	USA
49	Vanderbilt University	USA
50	Technical University Munich	GER
51	The University of Edinburgh	UK
52	Carnegie Mellon University	USA
52	Utrecht University	NED
54	Pennsylvania State University – University Park	USA
54	University of Heidelberg	GER
54	University of Melbourne	AUS
57	Purdue University - West Lafayette	USA
58	McGill University	CAN
59	The Hebrew University of Jerusalem	ISR
60	University of Zurich	CH
61	Rutgers, The State University of New Jersey – New Brunswick	USA
61	University of Munich	GER
61	University of Pittsburgh	USA
64	University of Bristol	UK
65	The Ohio State University – Columbus	USA
66	The Australian National University	AUS
67	Brown University	USA
67	King's College London	UK
69	University of Geneva	CH
69	**University of Oslo**	**NOR**
71	Ecole Normale Superieure – Paris	FRA
71	University of Florida	USA
73	**Uppsala University**	**SWE**
74	Leiden University	NED
75	Boston University	USA
76	**University of Helsinki**	**FIN**
77	Technion-Israel Institute of Technology	ISR
78	University of Arizona	USA
79	Arizona State University – Tempe	USA
79	Moscow State University	RUS
81	**Aarhus University**	**DEN**
82	**Stockholm University**	**SWE**
83	University of Basel	CH
83	University of Nottingham	UK
85	Ghent University	BEL
85	Indiana University Bloomington	USA
85	Osaka University	JPN
85	The University of Queensland	AUS
85	University of Utah	USA
90	University of Rochester	USA
91	The University of Western Australia	AUS
92	McMaster University	CAN
92	Michigan State University	USA
92	Rice University	USA
92	University of Groningen	NED
92	Weizmann Institute of Science	ISR
97	University of Strasbourg	FRA
97	University of Sydney	AUS
99	Case Western Reserve University	USA
100	University of Freiburg	GER

Appendix 3
Economic figures, Nordic Institute for Studies in Innovation, Research and Education (NIFU)

The figures are based on OECD (2012), "Research and Development Statistics: OECD Science, Technology and R&D Statistics (database)".

The figures are used to describe resources for research and development (R&D), as measured by expenditure and according to OECD definitions (Frascati Manual). To define expenditure for medical R&D, we have used the following methods:

- For the higher education, government, and private non-profit (PNP) sectors, we apply the OECD breakdown into fields of science, of which medical and health sciences is one.

- For the business enterprise sector, data from two industries (ISIC rev 4) have been included:
  - Manufacture of basic pharmaceutical products and pharmaceutical preparations
  - Manufacture of medical and dental instruments and supplies.

These two industrial categories are broad and not optimal for selecting R&D exclusively relevant to the medical sciences. On the other hand, other industries may also perform medically oriented R&D. An amalgamation of these two industrial categories is thus considered to provide the best estimate for the business enterprise sector R&D performance in the medical sciences and has therefore been chosen as a means to retain comparability between the countries.

Other notes on the availability of national data from the database:

The Nordic countries:

- For Finland and Sweden there are no data for R&D for the industry sector manufacture of medical and dental instruments and supplies; these data are classified as "confidential".
- Finland and Norway do not report data for the PNP sector.
- For Sweden there is no breakdown into fields of science in the government and PNP sectors.

Other countries:

- For France there are no figures on the medical sciences for the higher education sector, the government sector or the PNP sector.
- For Germany, the Netherlands and the United Kingdom there is no breakdown into fields of science in the PNP sector.

Figures for gross domestic product (GDP), population and exchange rates are extracted from and based on OECD (2013), "Reference Series", in "National Accounts at a Glance, 2013, OECD Publishing."

Appendix 4
Explanation of indicator calculations, Centre for Science and Technology, Leiden University (CWTS B.V.)

See more at: www.leidenranking.com/methodology/indicators#sthash.6KhZdnm2.dpuf

For the number of publications we weighted letters at 0.25 both in citations and publications, as these publications are not considered to be fully fledged scientific communications and their citation returns are often erratic.

To illustrate the calculation of the MNCS indicator, we consider a hypothetical research group that has only five publications. **Table 0** provides some bibliometric data for these five publications. For each publication, the Table shows the scientific field to which the publication belongs, the year in which the publication appeared, and the actual and the expected number of citations of the publication. The five publications are all document type articles. Citations have been counted using a variable-length citation window. As can be seen in the Table, publications 1 and 2 have the same expected number of citations. This is because these two publications belong to the same scientific field and have the same publication year and are of the same document type. Publication 5 also belongs to the same field and is of the same document type. However, this publication has a more recent publication year, and it therefore has a smaller expected number of citations. It can further be seen that publications 3 and 4 have the same publication year and are of the same document type. The fact that publication 4 has a larger expected number of citations than publication 3 indicates that publication 4 belongs to a field with a higher citation density than the field in which publication 3 was published. The MNCS indicator is derived from the average of the ratios of actual and expected citation scores of the five publications. Based on Table 1, we obtain

$$\text{MNCS} = \frac{1}{5}\left(\frac{7}{6.13} + \frac{37}{6.13} + \frac{4}{5.66} + \frac{23}{9.10} + \frac{0}{1.80}\right) = 2.08$$

Hence, on average the publications of our hypothetical research group have been cited more than twice as frequently as would be expected based on their field, publication year, and document type.

Table 0: Bibliometric data for the publications of a hypothetical research group

Publication	Field	Year	Actual citations	Expected citations
1	Surgery	2007	7	6.13
2	Surgery	2007	37	6.13
3	Clinical neurology	2008	4	5.66
4	Haematology	2008	23	9.10
5	Surgery	2009	0	1.80

Field of science	Thomson Reuters categories
Biomedicine	Anatomy & Morphology Biochemical Research Methods Biochemistry & Molecular Biology Biophysics Biotechnology & Applied Microbiology Cell Biology Cell & Tissue engineering Chemistry, Medicinal Cytology & Histology Genetics & Heredity Immunology Microbiology Microscopy Neurosciences Pharmacology & Pharmacy Physiology
Clinical medicine	Allergy Andrology Anesthesiology Oncology Cardiac & Cardiovascular System Critical Care Medicine Psychology, Clinical Emergency Medicine Dentistry, Oral Surgery & Medicine Dermatology Substance Abuse Endocrinology & Metabolism Gastroenterology & Hepatology Geriatrics & Gerontology Gerontology Hematology Infectious Diseases Integrative & Complementary Medicine Medical Ethics Medicine, Legal Medical Informatics Medical Laboratory Technology Medicine, General & Internal Medicine, Research & Experimental Medicine, Miscellaneous Clinical Neurology Neuroimaging Obstetrics & Gynecology Ophthalmology Orthopedics Otorhinolaryngology Parasitiology Pathology Pediatrics Rehabilitation Psychiatry Respiratory System Rheumatology Radiology, Nuclear Medicine & Medical Imaging Surgery Toxicology Transplantation Tropical Medicine Urology & Nephrology Peripheral Vascular Disease Virology
Health sciences	Health Care Sciences & Services Nursing Nutrition & Dietetics Public, Environmental & Occupational Health Sport Sciences

EU15: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom

Appendix 5
ESF Forward Look Personalised Medicine for the European Citizen [6]

Recommendations:
To frame the recommendations that have arisen over the course of the ESF Forward Look on Personalised Medicine, we have adopted a circle model. At the heart of personalised medicine lies the individual citizen, whose health status will be reflected by a new disease taxonomy informed by the multi-layered characterisation of physiological and pathological processes.

To support this new approach to classifying, understanding, treating and preventing disease, we highlight four overarching recommendations:

1. Data handling:
Comprehensive, accessible and interoperable datasets must be generated to support the development of a new disease taxonomy and allow for its on-going refinement and application.

2. Models and decision-making processes:
Models and decision-making processes must be revised to reflect a focus on the individual citizen at all levels, from assessment of the safety and efficacy of interventions, through HTA [health technology assessment] and reimbursement, to diagnosis, treatment and prevention.

3. Interdisciplinarity, participation and translational research:
Emphasis must be placed on stakeholder participation, interdisciplinary interaction, public – private and pre-competitive partnerships and translational research in order to develop the frameworks that support the vision of personalised medicine and healthcare.

4. Infrastructure and resources:
Dedicated funding and governmental support must be provided to ensure the availability of core infrastructure, including access to core technology and frameworks for education and training of professionals and the wider community.

ACADEMY OF FINLAND

Vetenskapsrådet

The Research Council of Norway

Ministry of Higher Education and Science
—
Danish Agency for Science Technology and Innovation

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