

Sport Sciences in the Nordic Countries

This policy paper presents in brief the major findings from the main report *Sport Sciences in Nordic Countries. Evaluation Report*.

The full version can be downloaded from: www.aka.fi/publications

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NordForsk, 2012
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Preface

NordForsk is an organization under the Nordic Council of Ministers which aims at facilitating cooperation in all fields of research and research driven innovation when this *adds value* to work being conducted in the five Nordic countries and three autonomous areas. In order to accomplish this, priority is given to thorough analysis as a basis for funding of joint Nordic research programmes. In this context we use “Nordic Research and Innovation Area networks” (NORIA-nets) to prepare for new initiatives.

The NORIA-net on Sport Sciences was started in response to an open call on such a preparatory action. It was granted money by NordForsk as it seemed to be well aligned with the NordForsk Strategy. The following institutions were represented in the NORIA-net: the Danish Agency for Science Technology and Innovation, the Icelandic Centre for Research, the Finnish Ministry of Education and Culture, the Research Council of Norway, the Swedish National Centre for Research in Sports, and the Swedish Research Council.

The report constitutes a basis for broad discussions on the potential of Nordic collaboration and provides a thorough analysis of the multidisciplinary field of Sport Sciences in the Nordic countries. The results of the evaluation of Sport Sciences are recommendations to NordForsk and Nordic Research Councils as well as to researchers and research institutions. The impact of a joint Nordic initiative in Sport Sciences appears to have potential to contribute to the solution of health challenges, such as obesity and other life style diseases. A more detailed description and analysis of Nordic Sport Sciences can be downloaded from the Academy of Finland web site.

NordForsk would like to forward our sincere thanks to the enthusiastic and very knowledgeable chair and manager of this NORIA-net; Professor Mikael Fogelholm, University of Helsinki, as well as to the chair of the steering group, professor Michael Kjær, University of Copenhagen. Included in our thanks are also the following NORIA-net participants in the steering and project groups: Erlingur Johannson, Pasi Koski, Per Nilsson, Sarianna Sipilä, Mats Ulfendahl, Nina Vøllestad. National working groups: Riikka Pellinen, Saara Leppinen, Minna Paajanen, Hilde Grindvik Nielsen, Magnús Lyngdal Magnússon, Christine Dartsch, Johan Dixelius and Anne Christiansen.

The following members of the international evaluation panel and authors of the report have made the content of this policy paper highly reliable and valuable: William Haskell (Stanford University), Karyn Esser (University of Kentucky), Peter Bärtsch (Heidelberg University), Stuart Biddle (Loughborough University), Jennifer Hargreaves (University of Brighton), Ron Maughan (Loughborough University) and Bart Vanreusel (Katholieke Universiteit Leuven). *Thanks for your excellent work!*


Gunnel Gustafsson
Director of NordForsk



1. Introduction

Throughout much of the 20th century, sport and exercise scientists conducting research in the Nordic countries established excellent reputations for their highly innovative basic and applied research. This rich history has provided a fertile yet challenging background for the current scientific community in its efforts to extend knowledge through exercise and sport sciences research that will benefit various subsets of the population – from patients to elite athletes and from toddlers to octogenarians.

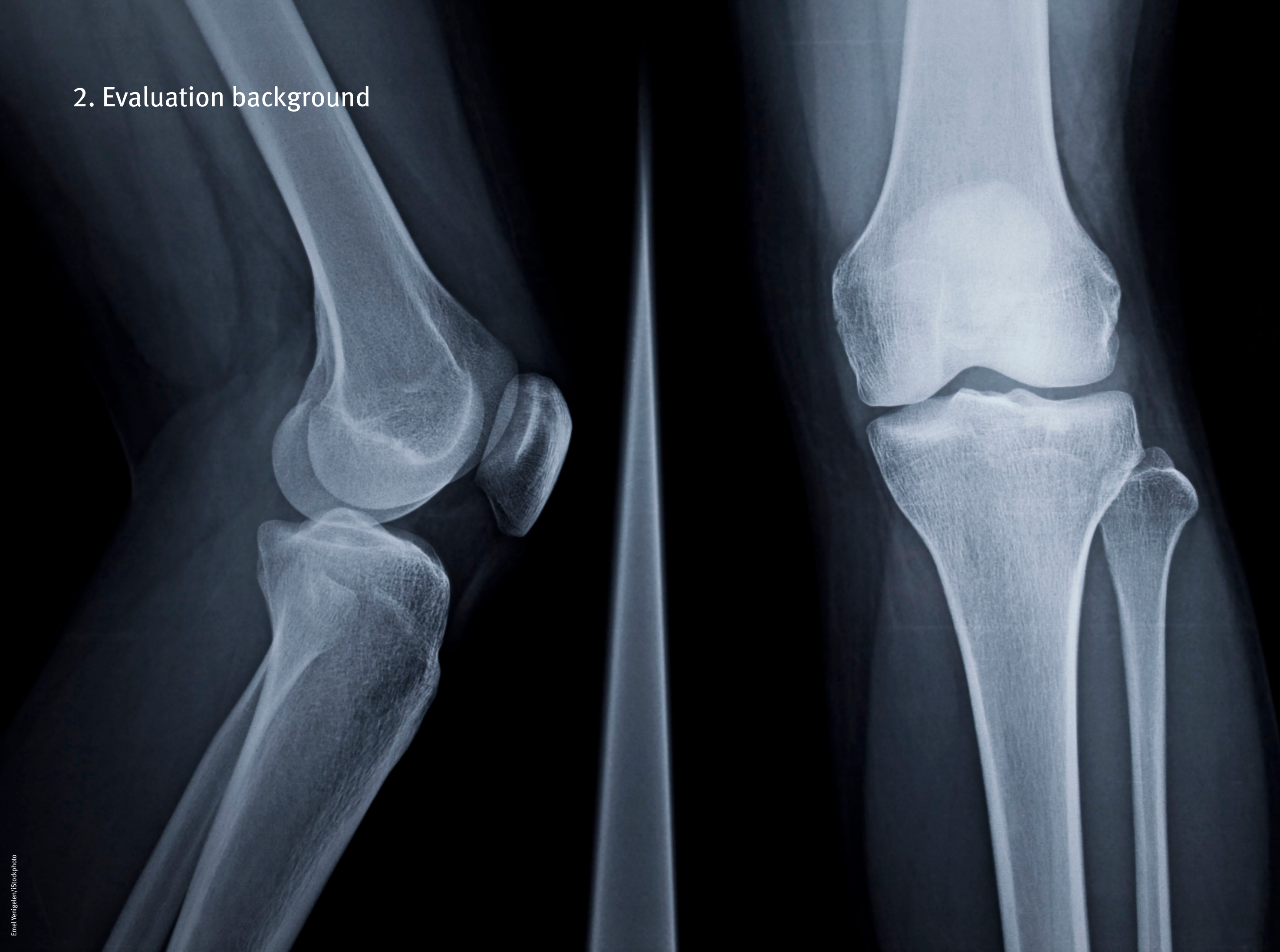
The idea to conduct an evaluation of sport sciences in the Nordic countries came from the Academy of Finland in 2009. The Academy had carried out a joint Finnish-Swedish evaluation of clinical medicine together with the Swedish Research Council (Vetenskapsrådet). After this project was completed, there was interest in finding a suitable research discipline as a pilot project for an overall Nordic evaluation.

There appeared to be a general interest among the Nordic countries in carrying out a pan-Nordic evaluation of sport sciences. The discipline was considered important but narrow enough for a joint evaluation, although it was immediately apparent that the widely dispersed research units would present a challenge. Sport sciences have an important societal role in all the Nordic countries, which was regarded as an additional reason for conducting an evaluation.

The Nordic evaluation of sport sciences was funded by NordForsk, 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. The management of the project was shared by a project group, chaired by Dr Mikael Fogelholm from the Academy of Finland (from 1 Aug 2011: University of Helsinki), and a steering group, chaired by Professor Michael Kjær from the University of Copenhagen. The Academy of Finland was the project coordinator and responsible for the overall evaluation process and financial administration.

The major purpose of the present evaluation was to determine the effectiveness of the cadre of present-day sport and exercise scientists in meeting current challenges, the strengths and weaknesses of the existing research and research training environments, potential future opportunities and how best to achieve them, and the key threats or barriers to achieving long-term success. The evaluation was conducted by an international evaluation panel that had access to the results of an extensive written questionnaire completed by individual research units in each of the five Nordic countries and the opportunity to interview a representative sample of sport sciences researchers in each country.

2. Evaluation background



2. Evaluation background

Sports and exercise, or being physically active, play a significant role in the lives of many people throughout their lifespan. Moving about under one's own power is an essential element of daily living for most people if they are to remain independent and productive members of society. Participating in sports or active recreation makes a major contribution to the wellbeing and quality of life of people of all ages. Data collected in many populations over the past 60 years have demonstrated that the least active or least physically fit members of a society are at the greatest risk of disability or premature death from major chronic diseases, and that the more physically active a person is the lower their risk will be. This protective effect of being physically active exists across both genders, among different races and ethnicities around the world and among people with different personal characteristics (e.g., normal weight or overweight, non-smokers or smokers, healthy people or people with various diseases). Thus it is becoming increasingly apparent that a habitual lack of physical activity and excessive sedentary behaviour are major clinical, public health and policy issues that need a more integrated and transdisciplinary science base.

Advances in technology in developed and developing countries continue to contribute to a decrease in energy expended in the performance of activities required for daily living. Increased use of various labour-saving technologies has reduced the physical activity required on-the-job, during commuting, while performing household chores and during recreation. We currently know enough about the negative health consequences of decreasing activity levels in an increasing percentage of the population to support public policies and programmes aimed at trying to counter the downward trend in daily activity. However, innovative research in the biological and social/behavioural sport and exercise sciences is needed if the continuing decline in physical activity is to be successfully reversed.

Sport has played a critical role in the history and culture of many countries around the world and the Nordic countries are no exception. In addition to its recognised health benefits, sport as both a participatory and spectator activity has an important role in society. For example, support for elite athletes and teams at the local, regional or national level provides opportunities for companionship among people from different segments of society. Other important benefits that might assist researchers in demonstrating societal benefit include the mental wellbeing outcomes of physical activity (including its role in slowing dementia), positive youth development through sport and physical activity, and community and environmental development through programmes of physical activity.

While the resources and personnel available to conduct sport sciences in the Nordic countries have historically been limited compared to those available in much more populated countries such as the US, Germany and the UK, Nordic researchers have made highly significant contributions in a variety of domains in the sport and exercise sciences. These contributions include training techniques used to enhance the performance of elite athletes; methods to aid in the prevention of sports-related injuries; enhanced methods for teaching sport techniques to athletes or rehabilitation exercises to patients, describing molecular-level changes in skeletal muscle in response to different types or profiles of exercise, establishing the role of increasing physical activity in the prevention of coronary heart disease, hypertension and type 2 diabetes; and defining the role exercise plays in the physical and mental development of young people and the retention of this as a person ages. Goals for the future should be to continue to conduct innovative research that addresses key issues faced by society, to look for new opportunities to conduct transdisciplinary research that forces investigators in specific disciplines to “think outside the box,” and to take advantage of existing resources and expertise to build new research paradigms throughout the Nordic countries.

For the purpose of this evaluation, sport sciences were considered from a broad perspective, so that they include any research conducted to better define the human response to gross body movement (exercise or physical activity). This includes the general domains of basic biological sciences (e.g., genetics, molecular biology, physiology), applied sport and exercise sciences (e.g., performance responses to training in the general public as well as elite athletes, biomechanics, the role of nutrition in athletic performance), sports medicine (e.g., exercise and sports traumatology, prevention of injuries during physical activity in the general public and athletes), the role of exercise and sports in health and disease (e.g., physical activity epidemiology, clinical research on selected patient populations), social sport sciences (e.g. sports history, humanities, sociology, philosophy, politics and economics, cultural and leisure studies, including relations of power, social divisions, diversity, discrimination, ethical issues, national/international perspectives and globalisation), and physical-activity-related behaviour change and the role of physical activity in mental health.



3. Objectives of the evaluation

The primary objective of the evaluation was to determine the strengths and weaknesses of sport sciences in the Nordic countries for the period 2006–2010. The evaluation panel was requested to obtain a current and candid view of the research focus and productivity of units located in various types of institutions, how decisions were made regarding topics to explore, the nature of the collaboration within and between units, what factors most contributed to research productivity or the lack thereof, and the amount of transdisciplinary research being performed. Given the importance of maintaining a cadre of well trained and motivated scientists and support personnel, the panel attempted to understand the strengths and weaknesses in the preparation of scientists at the Ph.D. and postdoctoral levels, job opportunities for junior scientists, the process of mentoring for enhancing career development and the process of replacement of professors and senior scientists at the time of retirement.

As defined in the terms of reference drawn up by the steering and project groups, the evaluation panel wanted to gain information on and insight into the following issues:

- 1) The focus and distribution of different scientific disciplines within sport sciences in the Nordic countries: Where is the work done? What is the focus? What is lacking? What are the structural weaknesses/strengths?
- 2) The overall quality of sport sciences and the recognition of strong and weak areas/disciplines (publication history, present activities)
- 3) Factors affecting quality:
 - a) Strategic issues (e.g. institutional research and publication strategies)
 - b) Human resources (size and composition of research groups; multidisciplinary, national and international cooperation, etc.)
 - c) Research infrastructure
 - d) External funding
- 4) Funding of sport sciences in the Nordic countries: adequacy, allocation and process of funding; advantages and disadvantages of a decentralised funding system
- 5) Linkage between science and societal applications (science-society interaction)
- 6) Evaluation of future prospects of sport sciences in the Nordic countries

The results of the evaluation are intended to inform the sport sciences leadership and funding agencies in the Nordic countries as to current research strengths from a national and pan-Nordic perspective, to identify where significant opportunities and weaknesses exist when looking to the future, and to provide recommendations regarding enhanced collaboration among research units across the Nordic region.

4. Description of the evaluation process



4. Description of the evaluation process

4.1 Steering and project groups

The overall plans for the evaluation were developed under the guidance of project and steering groups, which were in charge of the substance and strategic issues of the evaluation. The steering group consisted of the following members:

- Michael Kjær, Professor, Copenhagen, Denmark, chair
- Erlingur Johannsson, Professor, Reykjavik/Lagarvatn, Iceland
- Pasi Koski, Adjunct Professor, Turku, Finland
- Per Nilsson, Professor, Stockholm, Sweden
- Sarianna Sipilä, Research Director, Jyväskylä, Finland
- Mats Ulfendahl, Professor, Stockholm, Sweden
- Nina Vøllestad, Professor, Oslo, Norway

The evaluation was coordinated by the Academy of Finland with the help of national working groups from the organising funding agencies. The project group consisted of representatives from the agencies and was to lead and support the execution of the evaluation. The project group consisted of the following members:

- Mikael Fogelholm (Academy of Finland, Finland), chair
- Riikka Pellinen (Academy of Finland, Finland, external coordinator)
- Saara Leppinen (Academy of Finland, Finland)
- Minna Paajanen (Ministry of Education and Culture, Finland)
- Hilde Grindvik Nielsen (Research Council of Norway, Norway)
- Magnús Lyngdal Magnússon (The Icelandic Centre for Research, Iceland)
- Christine Dartsch (The Swedish National Centre for Research in Sports, Sweden)
- Johan Dixelius (Swedish Research Council, Sweden)
- Anne Christiansen (Danish Agency for Science, Technology and Innovation, Denmark)

- Monica Lund/Hanne Silje Hauge/Janina Lassila (NordForsk, Norway), external observers

4.2 International evaluation panel

The external evaluation was performed by an international evaluation panel of independent high-level experts. The steering group identified experienced scientists within the field of sport sciences and invited seven of them to be panel members. The panel consisted of four representatives of the sports biology and sports medicine fields and three representatives of the humanities, social and cultural sciences.

Chair

- Professor William Haskell, Stanford University

Members

Professor Karyn Esser, University of Kentucky

Professor Peter Bärtsch, Heidelberg University

Professor Stuart Biddle, Loughborough University

Professor Jennifer Hargreaves, freelance author and consultant

Professor Ron Maughan, Loughborough University

Professor Bart Vanreusel, Katholieke Universiteit Leuven

4.3 Evaluation steps

The evaluation process consisted of the following steps:

- Development of general evaluation process by project and steering groups
- Preparation of survey questionnaire by project and steering groups
- Selection of research units to receive survey questionnaire
- Sending out and receiving completed survey questionnaires
- Collating results from survey questionnaires for review by panel
- Selection of international evaluation panel members
- Review of survey results by panel members
- Development of procedures for interview of exercise and sport scientists from each country by panel
- Conducting interviews in each country
- Panel discussion on survey results, interviews and other sources, preparation of report
- Draft report reviewed by personnel from organising funding agencies
- Report finalised by panel

4.4 Evaluation criteria

The panel was instructed to evaluate sport sciences in the five Nordic countries using

a) data provided by the units responding to the survey,

b) interviews with scientists from each country, and

c) ancillary information provided by national coordinators in each country and published documents.

Using this information, the panel prepared reports for each of the three major domains of exercise and sport sciences at 1) the country level and 2) the Nordic level. Evaluations were not provided for individual scientists or specific research units or institutions. However, the panel did take into consideration the features and performance of individual units in the preparation of their country-by-domain commentaries.

4.5 Preparation of survey questionnaire

The planning of the survey questionnaire was based on the aims and objectives defined in the terms of reference. The format of the questionnaire was discussed and it was decided that mainly numerical data were to be collected. Publication data were collected using the questionnaire and not a bibliometric analysis, due to the diversity of disciplines and units included in the evaluation. Also, defining the journals to be included was challenging, as sport sciences research is published both in sport-sciences-related journals and in a wide variety of journals in more general fields of science. However, the panel decided to supplement the information from the surveys and interviews by conducting a bibliometric analysis.

4.6 Selection of research units to receive survey

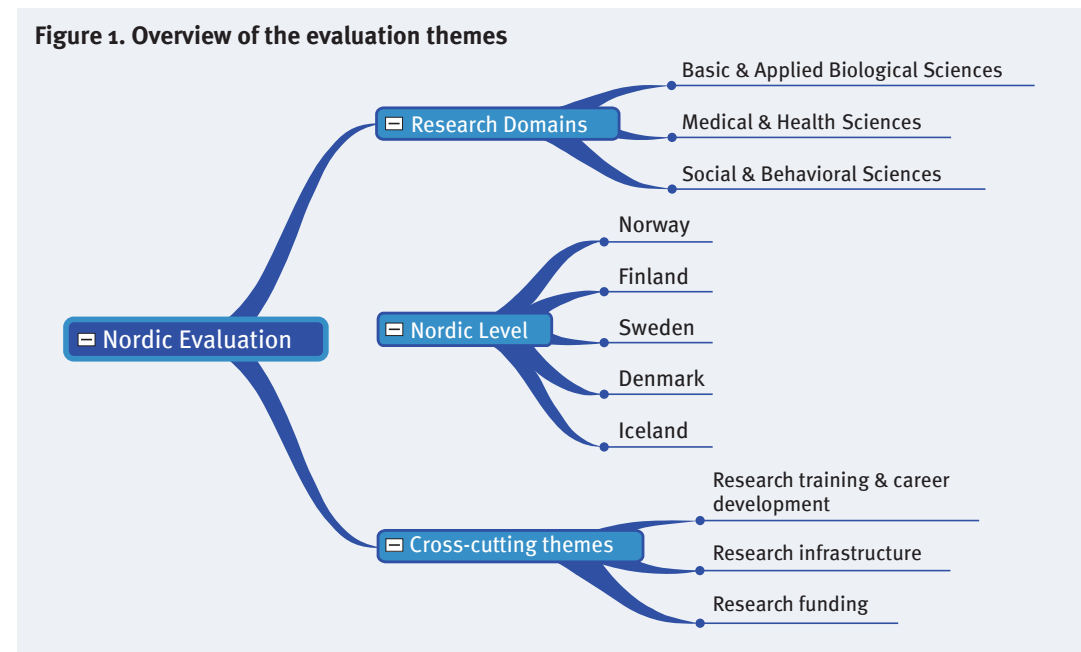
The research units to be evaluated were selected using the following criteria:

- Applied for a grant from a sports-relevant grant agency (governmental funding agency or large foundation).
- Identified by the national members of the project and steering groups, with possible consultation with selected researchers in the field.

The deadline for the selection of units was 15 October 2010. Responsibility for the selection was assigned to each national project group member with assistance from the steering group member.

4.7 Interview process

The national coordinators working with Academy of Finland staff and operating under the direction of the steering group invited scientists working in the participating units to attend an interview session with the panel. In Norway, Finland, Sweden and Denmark, scientists representing each of the three major domains (basic and applied biological sciences, sports medicine and health sciences, and social and behavioural sciences) were invited to these interviews. On average, nine scientists represented each domain for each of the four countries. Interviews were held in Oslo, Helsinki, Stockholm and Copenhagen. In Copenhagen, two scientists from Iceland were invited for interviews to represent all three domains. Each interview session lasted approximately two hours. The selection process was organised so that scientists at various stages in their scientific careers – from Ph.D. student to professor – were invited to attend the interview sessions.



4.8 Evaluation process and themes

The steering group decided to organise the review of the research within each country into three major domains: a) basic and applied biological sciences, b) medical and health sciences, and c) social and behavioural sciences (Figure 1).

After the survey and questionnaires had been returned, national coordinators in each country were requested to have each research unit completing a questionnaire, select a domain. In Finland and Sweden, each research unit selected only one domain, but in Norway, Denmark and Iceland, some units selected more than one domain. The panel decided to classify these units as “combined research units” for the purpose of tabulating the number of research units reporting data, the number of research personnel involved and the number of scientific manuscripts published in several categories during

2006–2010. However, the panel decided to provide reviews for all of the research reported in each of the three major domains within each country whether or not the research was conducted in a domain-specific research unit or a combined research unit.

Not included in the survey and interviews were research units in the Nordic countries that include exercise, sport or physical activity as a component of a more comprehensive agenda of basic science or chronic disease prevention or treatment. Researchers in these units do not view themselves as conducting sport sciences research but rather as conducting basic science or clinical research on specific medical disorders such as coronary heart disease, diabetes, metabolic syndrome or obesity.

A review of the international literature has identified manuscripts by scientists working in these units reporting on exercise/sport or physical activity and specific performance or health outcomes. Such research and resulting publications were not directly assessed as part of the survey or interviews but need to be recognised as part of the research being conducted on the health and performance effects of exercise and sport.

In an attempt to obtain an independent evaluation of the research productivity of all scientists in the Nordic countries conducting exercise and sport sciences, a review was conducted using the Web of Science website. This identified the number of manuscripts published during 2006–2010 in international, peer-reviewed sport and exercise journals considered to be the top journals in their category based on impact factor. Journals were separated into two general categories: a) biological and medical sciences, and b) social and behavioural sciences. The absolute number of publications by country was calculated, as was the rate of publication based on the population of the country and that of the five Nordic countries combined.



5. Main results of the evaluation

5.1 Research units and personnel

Of the 97 units participating in the survey, 16 were in Norway, 22 in Finland, 41 in Sweden, 15 in Denmark and three in Iceland. The units focused mainly on the domains of basic and applied biological sciences (27 units), medical and health sciences (32) and social and behavioural sciences (26). Twelve units were classified as conducting substantial science in two or more domains (combined units). Units in Denmark reported having the greatest number of appointed professors (expressed as full time equivalents, FTEs) (93.1), followed by Norway (73.1), Sweden (66.95), Finland (42.43) and Iceland (15.0). However, Sweden reported the greatest number of other senior researchers (98.7), followed by Finland (60.0), Denmark (50.7), Norway (16.1) and Iceland (15.0).

Along with having the greatest number of appointed professors, Denmark also reported the largest number of Ph.D. students (132.1 FTEs), followed by Finland (120.7), Sweden (114.9), Norway (71.91) and Iceland (2.25). All personnel numbers reported are for 2010. The number of research personnel within specific domains varied substantially from country to country. For example, in medical and health sciences, Finland reported the greatest number of personnel at all levels – from Ph.D. students to appointed professors.

5.2 Scientific publications

One generally agreed upon indicator of the ongoing success of a research unit is the number of manuscripts published in high-quality, peer-reviewed scientific journals. As part of the survey, each research unit was asked to provide the number of various types of manuscripts (e.g., original article, review article, monograph or book) published during each year for the period 2006–2010. For this report, articles published in the following types of journals were considered: international peer-reviewed journals, other international journals and national journals. Over the five-year reporting period, Nordic scientists in the 97 participating research units reported 4,829 articles in peer-reviewed international journals, equalling an average of 80 articles/month.

Units in Finland reported the greatest number of publications in international peer-reviewed journals (1,593), followed by Denmark (1,396), Norway (917), Sweden (877) and Iceland (46). When units are classified by major research domain, 2,041 of the articles published in peer-reviewed international journals were in medical and health sciences, 1,232 in units classified as combined, 1,086 in basic and applied biological sciences, and 470 in social and behavioural sciences.

Each participating unit provided a list of the ten most important exercise and sport sciences publications produced by their scientists during 2006–2010. These lists, along with the lists of publications in the curriculum vitae of key personnel in the units, provided the panel with an overview of the topics that were being investigated and where the results were being published. The panel made no systematic tabulations of these publications, but the review did reveal well-defined areas of concentration for each country in the three major domains. For example, in Finland, where 64% (14 of 22) of the participating units were classified in the medicine and health domain, topics on which substantial research had been conducted included: the effects of exercise on bone health (bone strength, osteoporosis, fracture prevention, lower back pain), muscle function and health, metabolic health (diabetes, obesity, metabolic syndrome, insulin resistance), cardiovascular health (coronary heart disease, stroke, blood pressure, lipids and lipoproteins) and successful ageing (maintaining or enhancing physical and mental functioning and independence).

To obtain an independent evaluation of the productivity of exercise and sport sciences researchers in the Nordic countries during 2006–2010, a search was made on the Web of Science to determine the

number of articles published by Nordic scientists in leading peer-reviewed sport and exercise sciences journals, as determined by their impact factor. Overall, many Nordic scientists appear to be highly productive based on these criteria. Despite the fact that the total population of the five Nordic countries is only 26 million, in the biological and medical sciences they were responsible for about 9.3% of all articles published in six of the top sports biology and medical journals worldwide, not including the Scandinavian Journal of Medicine and Science in Sport (in which they authored 54% of all publications).

Because of the greater diversity in the types of publications considered of high value in the social and behavioural sciences (e.g., monographs, reports, chapters and books), the Web of Science data for these domains are not as well defined. However, the data do indicate that the prevalence of publications by Nordic scientists in eight highly regarded journals in the social and behavioural sciences is good but not great. For example, scientists in Australia, with a population of approximately 22 million, published articles in the leading social and behavioural sciences journals on average 3.4 times more frequently than Nordic scientists during 2006–2010 (199 vs. 59 publications). Part of this might be explained by language constraints in the Nordic countries, but it also suggests that there is room for improvement.

5.3 Elite sport research

Both the written responses to the survey and the interviews carried out showed that there was a limited amount of recent or ongoing basic or applied research dealing with the performance of elite athletes, much less than the panel expected. The sport and exercise sciences across the Nordic countries have historically embraced the issues that are relevant to the performance of elite athletes. With very few exceptions, there was little evidence of any integration of elite athlete research with more resource-intensive basic and applied science research. The panel thought that this change in focus was probably a reflection of the availability of funding in this area.

It appeared that any funding currently available for research into elite athletes was devoted mostly to athlete monitoring and support rather than research. There were, however, some examples of the provision of funding from industry and regional government sources. The current picture may also reflect the geography of sports-related research facilities. It seems that there are good opportunities in Norway, where the Olympiatoppen centre is located immediately adjacent to the sport sciences university and some staff have joint appointments. Elsewhere, there seems to be a clear separation between athlete support services and clinical and laboratory research facilities. The world of elite sports provides some good research opportunities, and here the basic sciences have much to offer. A closer integration, including perhaps the identification of some specific funding mechanisms that would encourage greater communication and collaboration, should be considered. There were clearly different perspectives on how to approach the balance between basic and applied research, and on how efforts should be distributed across the field to balance the needs of public health and elite sport constituencies. In the elite sport arena, the need for coach education was emphasised, even if this required the investment of resources that would otherwise be directed towards research and the generation of new knowledge.

5.4 Research training and career development

Generally, the panel viewed the training of exercise and sport scientists in the Nordic countries as very good to excellent. However, some deficiencies were identified that caused significant concern among panel members when looking to the future. The quality of Ph.D. training varies quite substantially among research units across the Nordic countries and across domains. The panel attempted to determine whether Ph.D. students and postdoctoral fellows had access to forward-looking scientific thinking by mentors and colleagues, an opportunity to be personally immersed in the research process (e.g., designing and planning projects, conducting the research in a timely manner, analysing data, preparing reports and proposals) for an extended period of time, and exposure to scientists from other disciplines and fields of research.

Strengths in Ph.D. training include the process of scientific writing and the opportunity to participate in international conferences. From comments made during interviews, the panel concluded that many supervisors were fully engaged with other responsibilities, which limited the time at their disposal to provide guidance to Ph.D. students in the early stages of their studies. The panel concluded that the presence of more junior staff with a full-time research commitment would enhance the effectiveness of training in a variety of research methods.

During the interviews, scientists across Nordic countries and domains expressed the strong opinion that postdoctoral training has become essential for obtaining an academic research position. MDs who also had a Ph.D. degree were a possible exception. In hiring, greater value is generally given to scientists who have acquired postdoctoral training in strong academic institutions outside the Nordic countries, especially in the UK and the US. Obtaining postdoctoral training in selected European countries, including other Nordic countries, is considered more useful than obtaining postdoctoral training in a postdoctoral researcher's own country. Some exceptions to this opinion existed, especially in Denmark. The added value of obtaining research experience outside the broad discipline of exercise and sport sciences during postdoctoral training was expressed during some interviews. The panel concurred with this opinion.

Major concerns by the panel regarding training and career development in the exercise and sport sciences included the potential training of too many Ph.D.s given the limited number of funded postdoctoral positions available. However, some of the senior scientists interviewed indicated that the pool of good Ph.D. candidates has been decreasing, and thus some reduction in the funding of Ph.D. training might be considered. While the average time spent obtaining a Ph.D. was reported to be decreasing in each of the Nordic countries (the target appears to be ≤ 5 years), a number of recent or current candidates spend at least 6–8 years, in part due to their financial need to seek other paid employment such as teaching or because they have a family. It also appears that a number of Ph.D. students delay completing their degree because of the limited number of research positions available in academic research units.

Another issue of some concern to the panel regarding career development was the number of professors and other senior scientists near, at or over retirement age and, in many cases, the apparent lack of specific plans for leadership transition. In some cases, the replacement of a professor is dealt with by a senior official or committee in the academic institution who may decide to redirect the mission or focus of a research unit to scientific issues outside the discipline of exercise and sport sciences. The likelihood of this happening is reduced if the research unit is highly productive, routinely obtains funding from outside sources and produces innovative research, making the unit an international leader in its domain.

5.5 Mobility of researchers

The panel considered the general lack of mobility among Nordic sport sciences researchers to be a subject of concern for the future. Nordic-wide, nearly 75% of the units reported no visits to another unit or less than one visit of up to three months each year by one of their researchers. Also, except for units in Denmark, only about 50% of units reported any scientists having visited their unit between 2006 and 2010. The panel feels that the lack of national and international mobility of sport scientists to and from many of the research units restricts the development of new ideas and contributes to the lack of innovation and major collaborations.

Based on information provided in their curriculum vitae, questions were raised by panel members about an apparent lack of mobility over the careers of some current senior researchers. In many cases, these researchers have spent most of their careers in the same institutions where they received their education. The issue here is the apparent benefit of the cross-fertilisation of ideas leading to innovation when researchers who have trained and worked at different institutions join together.

5.6 Research funding

During 2006–2010, the 90 participating units in all five Nordic countries providing funding data in their survey responses reported receiving in excess of EUR 47 million for conducting research or research training (seven units did not provide data on funding). Approximately 43% of this amount was internal funding (primarily provided by the institution) and 57% came from external funding sources. A majority of the external funding was provided by the national governments. Units in Finland reported receiving 81.5% of their external funding from their government while units in Denmark received only 45% from their government (Sweden 76.9%, Norway 72.6% and Iceland 61.5%). Units in Denmark reported receiving 30.2% of their external funding from private foundations, which is much more than in any of the other Nordic countries, and overall in Denmark approximately 10% of all external funding came from international sources.

Much of the external funding, regardless of source, is provided in response to investigator-initiated grant proposals where the awarding of funds is highly competitive. The review process for research proposals submitted to the main government funding agencies in each country is well established and considered to be of high quality by the panel. Despite the general decline in funding for biomedical, social and behavioural research from most sources following the recent general economic decline, no evidence was provided to the panel that there was a significant decline in the funding of sport sciences research in the Nordic countries during 2006–2010. During this period, and apparently for a period of time previously, there was a general shift in research priorities in the sport sciences through most of the Nordic countries, moving from elite athlete and sport performance research to more research on the health risks of inactivity and the benefits of being physically active throughout life. This shift appears to have been driven, at least in part, by public policy and a public health agenda directed at the prevention and treatment of chronic degenerative diseases.

During the interviews and discussions, the panel members also considered the funding distribution among the sources and generally agreed that concerted efforts should be made to obtain an increase in funding from international sources, especially from European agencies. Multidisciplinary research collaboration among countries was considered a priority in this effort. Discussions were also held regarding different funding strategies, including the value of funding small units that work very independently on relatively small but highly targeted issues versus large multidisciplinary units (possibly “centres of excellence”) that are designed to facilitate collaboration and see their mission as solving large, complex problems. No final conclusion was reached but the prevailing opinion favoured both approaches: small units with a history of high productivity and innovation should be encouraged as well as large, effectively directed, multidisciplinary units (centres that could be either physical or virtual).

5.7 Research infrastructure

The survey sent to research units did not include any questions on infrastructure availability or needs for the future. During the interviews, investigators did not indicate that a lack of research infrastructure was a major impediment to future productivity or innovation. However, well-thought-out and well-funded facilities would probably lead to greater and more effective collaboration.

All the Nordic countries considered large national medical and mortality databases and ready access to them to be valuable infrastructure resources. However, the panel concluded that these databases have been underused by sport sciences researchers. For example, very few plans to take advantage of these opportunities were evident during the interviews. Researchers indicated that materials in biobanks (e.g., blood, muscle biopsies and DNA) are often not available to investigators from other institutions due to issues concerning the ownership of biobank materials that limit collaborations. Finding better ways of sharing samples and enhancing collaboration in this area should be a target for the near future.

In Denmark, there was general agreement among the interviewed scientists on the need to focus on areas of strength where major infrastructure investment would help develop centres of national and international excellence. It was acknowledged that this would require strategic planning and the identification of relevant research questions.

5.8 Limitations of the evaluation

- The panel did not conduct site visits to any of the research units.
- Not all research units conducting exercise or sport sciences research in the Nordic countries participated in the survey or the interviews. The exact under-representation was not well established but appears to be 20% or less in each of the countries.
- A standardised approach was not used across countries in assigning research units to primary domains. In two countries (Finland and Sweden) each participating unit was assigned a specific domain, and in three countries (Norway, Denmark and Iceland) some units were listed as conducting research in two or three domains.
- Some large institutions with multiple departments/divisions/institutes responded to the survey as a single unit while in other large institutions multiple units responded individually to the survey.
- The panel had limited access to standardised information on the funding of research from each of the countries, which limited commentary on various issues of research funding.
- The interview groups were too large and the interview methods not well developed.

6. Panel conclusions and recommendations



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6.1 Major conclusions

The panel came to these general conclusions in response to the following questions:

1. *What is the international quality and status of sport sciences in the Nordic countries?*

Taken as a whole, the quantity of sport sciences conducted in the Nordic countries during 2006–2010 was considered excellent but with substantial variability across units, domains and countries. The overall rate of publication reported by scientists working in the participating units in international peer-reviewed journals was 80 articles/month during the five-year evaluation period. A review of articles published in six of the highest-impact sports medicine and biology journals by scientists from countries throughout the world during 2006–2010 indicated that 9.3% of the articles were authored by scientists from the Nordic countries (note: The origins of all authors of a particular paper were included in this search. This means that the Nordic authors could be listed as co-authors and the first or senior author could be from another country). This rate is somewhat higher than for countries with reasonably comparable populations and active exercise and sport sciences research programmes, such as Australia (8.2%) and Canada (8.9%). Also, some Nordic exercise and sport sciences research units have had success in the publication of articles in high-impact journals outside the exercise and sport sciences realm, including publications in *The Lancet*, *BMJ*, *The Journal of the American Medical Association*, *Circulation*, *European Heart Journal* and *Diabetes*.

2. *Is the research in sport sciences creative, innovative and likely to produce new lines of thinking?*

Historically, major areas of exercise and sport sciences research conducted by scientists in the Nordic countries have been considered ground-breaking and highly innovative in both the disciplines of exercise for physical performance and physical activity for public health and welfare. For example, innovation in the Nordic countries was made possible by the collaboration of physicians and exercise physiologists developing new laboratory methods or applying methods from other disciplines to study responses to exercise in elite athletes, the public and patients. In addition, our understanding of the negative health impact of too much inactivity and the health benefits of being physically active has been significantly enhanced by research conducted in all of the major domains of sport sciences in the Nordic countries.

The panel's conclusion is that some of the innovative quality of past research has been lost in the Nordic countries. Staying innovative is a constant challenge and it takes time, resources and facilities to explore new ideas and have the freedom to take chances (to fail as well as to succeed). Innovation is greatly facilitated by the successful recruitment and training of talented young scientists and transdisciplinary collaboration. Little evidence was presented to the panel of innovative research regarding elite athletes, except in the prevention and treatment of some sports-related injuries. It appears that a majority of the resources and efforts spent in the area of elite athletes are used for athlete evaluation. Good examples of research on sports-related injury prevention and treatment can be found in Norway, Sweden and Denmark, with less apparent examples in Finland and Iceland.

One way to increase the likelihood of significant innovation is to develop collaborative programmes of research in which basic and applied sport scientists work closely with coaches and athletes at elite training centres. Research on the relationships of exercise and sports and the development and progression of atherothrombotic vascular disease and metabolic disorders such as obesity, metabolic

syndrome and type 2 diabetes remains important and reasonably innovative, especially in Finland and Denmark.

However, the extensive scientific emphasis placed on describing the relationship between physical activity, sports participation or physical fitness and the prevalence of these disorders (descriptive epidemiology) does not leave much room for continued innovation when the question being asked is only about what this relationship is. Innovation is much more likely to occur if the key questions deal with the why or how. What we need are better-designed experiments that provide biological mechanisms for the associations or causal links between behaviours and clinical outcomes. Similarly, we need more well-designed and innovative behavioural interventions.

3. *Which research fields/areas are strong/weak in each country?*

In the Nordic countries, the domain with the highest research productivity in 2006–2010, based primarily on publications in high-impact journals, was that of medicine and health (including sport/exercise traumatology), followed by basic and applied biological sciences and social and behavioural sciences. This ranking partly reflects the number of scientists working in each domain. None of the three major domains were considered weak by the panel, but there were specific areas of concentration within the domains that were much stronger than others. In Norway, strengths are apparent in applied biology, sports medicine (especially sports traumatology) and the social sciences, with less focus being placed on basic biology and the behavioural sciences.

The dominant strength in Finland, based on the number of units conducting research and their production in terms of manuscripts, is the domain of medicine and health, with a major focus on the prevention of chronic diseases. Sweden continues to pursue its strong focus on basic and applied biological sciences and on social and behavioural sciences. Much of its research in the medicine and health domain is in sports traumatology. Sport sciences research in Denmark is quite diverse across all three domains in the participating units, but overall continues to remain exceptionally strong in the basic and applied exercise sciences. Recently, major research domains in the participating units in Iceland have been public health (especially obesity-related chronic disease), sports traumatology and the social sciences.

4. *What are the differences between successful and non-successful domains/areas?*

One key factor in the success of a research domain is the availability of adequate and well-placed long-term financial support. The panel was informed that in much of the Nordic region over the past several decades, there has been a funding shift by national government funding agencies, moving away from elite sport research and towards research in the medical and health sciences (including research in health-related behaviour change). Another factor contributing to a decrease in the strength of elite sport research is the difficulty, if not failure, of demonstrating the relevance of this research to the general population. How does this research influence the health, wellbeing or quality of life of various segments of the general population?

Successful research units have a clear and continued focus on important questions they want to answer, develop the expertise (including collaboration) needed to conduct the research, design appropriate studies and effectively conduct the studies. To operate in this manner, units need high-quality research

training programmes, long-term institutional commitment and appropriate facilities and equipment. However, if the scientists are not innovative in their thinking and are unwilling to explore new ideas and approaches, even well-organised and well-funded units will not produce innovative research.

During the interviews with scientists from the various Nordic countries and domains, there was no consensus regarding the issue of centralisation versus regionalisation of research facilities in the exercise and sport sciences. Centralisation allows for better access to collaborators and expensive facilities or equipment, but regionalisation provides greater independence, which in turn may help achieve enhanced innovation.

5. Which are the most successful research units/groups in each country and why?

The panel was instructed not to attempt to evaluate or report on specific investigators or research units. No site visits were made to the units.

Throughout the Nordic countries, successful research units in the sport sciences come in all sizes, shapes and locations. There are some large centralised units such as the Institute of Sports Science and Clinical Biomechanics (ISSCB) at the University of Southern Denmark, the Norwegian School of Sport Sciences (NSSS), the Norwegian University of Science and Technology (NTNU) and the combined units at the University of Jyväskylä in Finland that have made highly significant research contributions over the years and continue to do so. All these institutions also play a very important role in the training of young scientists.

However, there are small units spread throughout Norway, Finland, Sweden and Denmark that continue to produce significant and innovative research. A variety of factors seem to contribute to the success of these units, including talented leadership, collaboration with other units in the region or throughout the country and internationally (especially transdisciplinary collaboration) and local funding, usually the result of the unit's demonstrated value to the community.

6. What has been the societal impact of exercise and sport sciences research in the Nordic countries?

The issue of impact was not addressed in the survey sent to the research units. During the interviews, however, the impact of research in each country was discussed briefly. In most cases, this is not an issue frequently addressed by exercise and sport sciences, except where the research is linked to a specific population such as elite athletes or people with diabetes, or in dealing with issue of public health. It is likely to be an area of increasing importance in the future.

It was the general view that the development of knowledge by the sport sciences research community has been widely applied in elite sports in the form of support services at training facilities. However, there seemed to be little or no systematic evaluation of whether this research has had any effect on sports performance. This may be reflected in funding and in a limited interaction between research scientists and coaches.

Research in the field of musculoskeletal health has had a substantial impact on the international scientific and therapeutic communities. Since it is a rapidly developing field the impact at an applied clinical level is still evolving, except for injury prevention and treatment in football and skiing where it has been adopted internationally. Research on the role of exercise in bone health, such as in the prevention of osteoporosis, has had an impact on public health and medical practice guidelines.

In the opinion of the panel, the potential offered by a strong exercise science community to the field of chronic disease prevention and rehabilitation was not fully appreciated by medical professionals in the Nordic countries – either by those charged with implementation of lifestyle promotion activities or by those engaged in research in these areas. However, a number of physical activity promotion campaigns and programmes in support of chronic disease prevention and healthy ageing have used the results of exercise and sport sciences research conducted in the Nordic countries.

6.2 Major recommendations

The steering group requested that the panel make recommendations a) for developing sport sciences in the future, with special reference to Nordic collaboration and b) for organisations that provide funding to sport sciences research.

1. The panel recommends that all Nordic countries continue to pursue their success in the medical and health sciences with a strong emphasis on enhancing collaboration within and between Nordic countries. The issues related to the role of physical activity in the prevention and treatment of major chronic diseases are similar across the Nordic countries and **effective collaboration would enhance the opportunities for answering key questions** related to causality, mechanisms, dose-response and behaviour change. Success in this area would be enhanced through a greater number of transdisciplinary research programmes.
2. Because of the complexity of exercise as a research topic, the panel recommends that **incentives be provided for multidisciplinary teams** of investigators to work closely together using systems-based approaches to address fundamental principles underlying adaptation to exercise training/physical activity. Such incentives could include special funding for integrative laboratories or centres and for transdisciplinary Ph.D. training programmes. Collaboration is a learned research skill and early training at the Ph.D. level should lead to more effective multidisciplinary research teams in the future.
3. Little discussion was held during the interviews with basic and applied biological scientists about inclusion of genomic/proteomic or metabolomic technologies in existing major human exercise intervention studies. The limited expertise in these areas, which are extremely demanding in terms of both human and physical resources, will reduce opportunities for innovative exercise-directed genetic as well as gene-environment research. The panel recommends that consideration be given to the **development of pan-Nordic programmes for exploring the genomic and genetic basis of performance and health responses** to changing levels of physical activity and exercise training.
4. Research over the last 50 years has established the importance of being physically active throughout life. At the same time, however, daily requirements for physical activity continue to decrease across the Nordic countries. What have not been adequately documented are the major factors mediating or modifying this decline, and even more importantly, what strategies are needed to reverse this downward trend. **Priority should be given to funding transdisciplinary research teams that involve at least exercise specialists, behavioural scientists, built environment scientists, social scientists and urban planners**, to design and conduct studies for identifying effective programmes for enhancing the habitual physical activity of specific subsets of the population, including people with disabilities.
5. The panel recommends that scientists at all levels endeavour to **submit more manuscripts to highly-rated journals** within and outside the sport sciences discipline to help establish international recognition, to facilitate international cooperation and to increase opportunities for obtaining collaborative research partners from other countries. This goal is especially important for Iceland. Achieving this goal will likely require a concerted effort to increase the quality and relevance to key issues of the research conducted in many of the units.
6. It is the opinion of the panel that the Nordic countries have played and should continue to play a major international role in research on elite athlete performance including the prevention and treatment of sports-related injuries. However, if this research is to be innovative, **new collaborations need to be established between elite athlete testing and training centres and basic and applied scientists** within and outside the exercise and sport sciences and across the major domains considered in this evaluation.

7. Nordic scientists primarily conducting health research in disciplines other than the exercise and sport sciences have developed a number of large databanks. The panel recommends that a systematic plan be developed in each country on **how these databanks can be more effectively used to help address major unanswered questions dealing with the role of exercise and sports in significant health and other societal issues**. It is also very important for exercise and sport scientists to play a more active role in the development of new databanks to help ensure the inclusion of appropriate measures of physical activity or exercise, sports participation and components of physical fitness as well as appropriate outcome measures.
8. The panel recommends that consideration be given to re-establishing annual **pan-Nordic courses and workshops for Ph.D. students and possibly postdoctoral fellows** to enhance the development of links with faculty and students from other Nordic countries. Establishing and maintaining links with fellow Ph.D. students working on similar problems in different environments provides valuable experience in the implementation of innovative research. Consideration should also be given to a similar programme with non-Nordic countries.
9. The panel was favourably impressed by the recent rise in research training of physiotherapists in exercise and sport sciences, especially in Sweden. The panel also appreciated the potential of this group to significantly increase the research carried out on the diversity of approaches for the prevention, treatment and rehabilitation of exercise-related injuries. The panel recommends that all Nordic countries seriously consider ways to **involve more physiotherapists in their Ph.D. and postdoctoral training programmes and to make senior research positions more readily available to them**.
10. The panel recommends that **Icelandic researchers in social and behavioural sciences look at the possibility of conducting more research in the field of leisure, exercise and tourism**, and that they look for commercial sponsors who have vested interests in these areas. Such research is suggested because of the importance of these topics to the Icelandic economy. Exercise- and sport-based tourism, including lifestyle sports, is a growing industry and Iceland is an ideal location for collaborative research in this area.
11. Trainees and faculty should be encouraged to pursue **complementary research training as postdoctoral scholars in other parts of the Nordic countries or in the EU or North America**. The research programmes will stagnate without the infusion of new ideas and technologies, and there is little likelihood that these will be introduced if trainees remain at the same institutions throughout their careers. Funding agencies should make such training a higher priority.
12. There was substantial concern among the panel members that a **long period of training for Ph.D. students (> five years) creates a culture that leads to limited productivity**. There are probably multiple factors that contribute to the slow progression of many students, so addressing this will require more than just funding changes. This is an area in which team building around common research topics could provide a more active research (and training) environment that would generate enthusiasm for pushing projects to an international scale.
13. To increase collaboration among research units the panel recommends that **special funding programmes be established, only available to research proposals that include new collaborations between research units or new collaborations with scientists working outside the exercise and sport sciences**. Joint Nordic funding should be considered for collaborations of scientists among the Nordic countries and other European countries. Such international collaborations already exist, but in the view of the panel an increase in such funding would enhance the opportunity for research innovation and improve the competitiveness of Nordic sport sciences research in its pursuit of international funding.
14. The major organisations in each Nordic country that provide funding for the training of Ph.D. students and the main institutions conducting this training should organise **comprehensive evaluations of the Ph.D. training in exercise and sport sciences**. The primary target of such evaluations would be to determine whether appropriate research mentoring is provided, whether financial support is available to fund a training programme that enables most students to obtain a Ph.D. in a maximum of four years, and whether funding mechanisms operate in a way that does not result in a funding gap between Ph.D. completion and obtaining a funded postdoctoral position.
15. Collaboration among countries to **achieve a major Nordic Centre of Excellence in a specific domain within the sport sciences** should be considered by the sport science leadership in the Nordic countries. It should be determined whether such a proposal could be submitted to NordForsk, both for funding the development of a plan and to secure a lead funder for such a centre.