

National Knowledge Agenda

Sport and Exercise

From the steps to the podium



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General introduction

1 — Investing together, performing together!

A broad agenda with societal urgency — From improving children's learning performances to delaying the onset of Alzheimer's disease. From productive employees to playing football to counteract radicalisation. From including the disabled to economic export product. Sport can make a positive contribution to dealing with social, cultural and healthcare issues more effectively and can stimulate both personal and economic growth.

Two conditions must be satisfied if these contributions are to be realised in a structural, sustainable and successful manner.

One: all parties involved must collaborate to realise the evidence-based added value of sport in practice.

Two: politicians, industry, healthcare and health insurers must recognise that it is in everybody's interest that sport acquires this key role.

Future proof and strong content — With this Knowledge Agenda we are developing a sustainable partnership between universities, universities of applied sciences, sport, local and national government and industry. The Agenda is a unique collection of all research relevant for sport and exercise, expresses a clear vision and strategy, has a strong content and is future proof. The Agenda emphasises a broad multidisciplinary approach: from individual psychological processes to physiological measurements, smart materials and virtual reality. A new aspect is the vital role of big data and data science as a connecting and crossdisciplinary link between the three main themes of this agenda: 'Improving Performance', 'Exercising a lifetime' and 'The values of sport'.

International top position — The Knowledge Agenda also has international ambitions. In sport research we closely follow the United States and the United Kingdom. Based on current developments, the Netherlands is expected to develop into a major player in this field over the next five years. Universities, universities of applied sciences and other research institutes together form an infrastructure for internationally renowned research. Furthermore, Dutch data science is in the international top. Together with the countries that organise the Olympic Games, we want to develop state-of-the-art knowledge and innovation. The aim is a long-term programme and an international network based around the Olympic cycle.

Low threshold, local and innovative — We want Dutch sports practice to be able to benefit directly from new scientific data and insights. That requires more than just an agenda or a document; it requires a proactive network and innovative methods to involve sports practice in the research and the results that emerge from this. Many companies, sports associations, coaches, municipalities and clubs are not yet making use of the possibilities that knowledge and innovation can offer. At the same time there are few other domains in which knowledge and practice lie so close together and where the ambition to establish close links between the two has been so clearly expressed. 'Sport and Exercise' can therefore be an inspiring example for collaboration, innovation and implementation. This does, however, mean that national efforts need to reach out and involve both regional and local networks. The practice-oriented research carried out by universities of applied sciences can fulfil an important bridging function between science and practice by involving current and future sports professionals. Universities of applied sciences and the already successful academic collaborative centres link a strong regional and local network of knowledge partners to the national research efforts. Implementation research will also be deployed to develop new, innovative methods and tools that will simplify and accelerate this transfer of knowledge.

Consideration for the negative aspects of sport — Meanwhile we will not turn a blind eye to the negative aspects of sport. Participating in sport entails the risk of injury, overtraining and performance anxiety. In the world of sport we are also confronted with phenomena such as doping, match fixing, aggression, violence, discrimination, social exclusion and corruption. Instead of ignoring these negative aspects or brushing them aside we will give them our full attention. Because the knowledge we can acquire about how to reduce these phenomena in sport will benefit the world outside of sport as well.



Sustainable long-term partnership — This Knowledge Agenda is the starting point for jointly developing a sustainable national partnership in sport and exercise research and innovation. The recently established university of applied sciences platform for lecturers and possibly a similar platform in the future for university researchers and professors makes this close collaboration and involvement tangible. Stimulation funding from the Ministry of Health, Welfare and Sport, funding from The Netherlands Organisation for Scientific research (NWO), The Netherlands Organisation for Health Research and Development (ZonMw), Technology Foundation STW and The Taskforce for Applied Research (NRPO SIA) as well as the research funding from universities must lead to a sustainable long-term partnership between universities, university of applied sciences, local and national government and industry. All of this will take place under the motto: ‘investing together, programming together and performing together!’

2 — Together we are stronger

Multidisciplinary collaboration — Multidisciplinary collaboration, crossovers between sectors and methodological and technological innovation are necessary to increase the level of knowledge about improving performance, exercising a lifetime and the values of sport. This concerns collaboration between very diverse disciplines such as the biomedical sciences, civil engineering, linguistics, health sciences, business studies, philosophy, serious gaming and smart materials. In fact there are few disciplines that cannot play a direct or indirect role in sport research. This is due to the different dimensions of sport and the impact sport has on various aspects of society (and vice versa). This will be explained in greater detail for each of the three main themes.

Smart technology — Smart measurements and smart technologies are important for sports professionals. Examples are the use of cameras and real-time feedback systems, computer simulations and virtual reality applications. Advanced technology can be used to measure, monitor, analyse, guide and coach top level sports professionals on a 24/7 basis. Smart sensors determine strength and aerodynamic posture. Heart rate, speed, strength and position meters record physical exertions. Also the use of very diverse materials and the optimisation of sports equipment are important: from clothing to prostheses and rowing boats. Data also needs to be collected in a systematic and structural manner to obtain new insights and to make predictions with the help of data science. That will enable elite sports professionals to win more medals and it will give society more pleasure in and knowledge of exercise.



Existing initiatives will be consolidated — The three themes rely on a longer established collaboration between universities, universities of applied sciences and research consortia that industry, representatives from sports practice and other research institutes also participate in.

Partners include NOC*NSF, Knowledge Centre for Sport Netherlands (previously NISB), *VeiligheidNL*, *Vereniging voor Sportgeneeskunde (VSG)*, the *Nederlands Paramedisch Instituut (NPi)*, the *Nederlandse Vereniging voor Fysiotherapie in de Sportgezondheidszorg (NVFS)*, Mulier Institute, Huygens ING, the Netherlands Institute for Social Research (SCP), National Institute for Public Health and the Environment (RIVM), the programme Safe Sports Climate, and national sports associations.

Most knowledge institutions carry out research into sport and exercise and this is often in an institutionalised context. The size of these efforts differs. For example, university medical centres make some of their contributions through LOSO (National Network Sport and Health Research). In Groningen a sport science institute has been set up in which various faculties from the University of Groningen, University Medical Center Groningen and Hanze University of Applied Sciences as well as the municipality work together. A similar initiative has been developed in Amsterdam with AISS, the Amsterdam Institute of Sport Sciences in which the University of Amsterdam, VU University Amsterdam, Amsterdam University of Applied Sciences, Amsterdam Medical Centre and VU University Medical Centre have consolidated their strengths. Wageningen University & Research Centre and research institutes such as NIZO food are investigating the relationship between nutrition and health.

Utrecht University has a focus area Sport & Society/Healthy Urban Living, in which various faculties – Law, Economic & Governance and Geosciences – as well as the University Medical Center Utrecht work together on research into the societal aspects of sport.

Delft University of Technology has consolidated its sports-related research in the Sports Engineering Institute that involves various disciplines such as civil engineering, industrial design, mechanical engineering, electrical engineering and aerospace engineering. Five faculties from Eindhoven University of Technology collaborate with various institutes of Fontys University of Applied Sciences in the area of sport, exercise and technology and are connected with each other via the Sports and Technology foundation. Highly relevant sport research is also being carried out at the universities of Leiden, Rotterdam, Nijmegen, Maastricht and Twente.

This Knowledge Agenda consolidates these various efforts and strengths at a national level.

The connecting factor: big data & data science

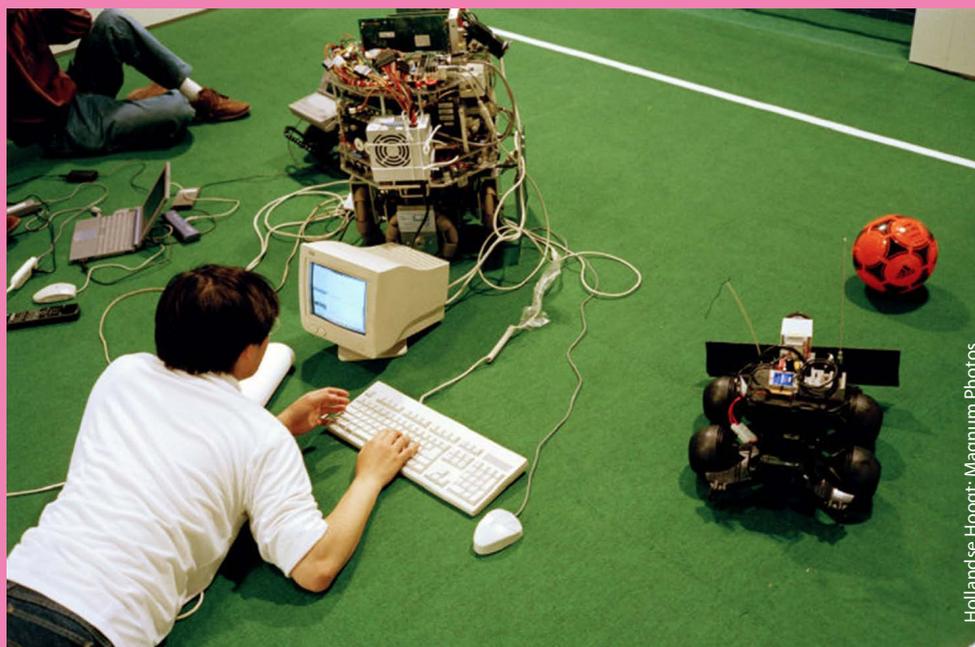
Big data is everywhere — The importance of big data is the link between the three themes of this knowledge agenda. The production of sports-related data is growing rapidly. Athletes, scientists, companies and governments collect an enormous amount of data from competition results to weather data and physiological measurements. Apps, trackers and sensors make it possible to accurately monitor and analyse the behaviour of individual athletes. Another interesting source of data is quantified self-exercise in which people use wearables to collect their personal data and subsequently use these to adjust their behaviour. The data are potentially important for sports and health research because they can provide insights into the effect of sport and exercise.



Surprising insights, specific suggestions — Big data only acquire added value if they are combined and analysed smartly. That is the realm of data science, a discipline that uses methods such as data mining, text and image analysis, machine learning and visual analytics to discover robust and interesting patterns in large volumes of data. Surprising and reliable insights can be obtained from these patterns and data scientists can use these insights to make predictions and provide concrete suggestions. Data science has demonstrated its worth in various areas such as talent scouting, the development of successful strategies, new organisational concepts, deducing people's motives to participate in sport, setting up interventions for specific target groups, and detecting fraud.

Individual predictions — Data science can also be used to make analyses and predictions about individuals. This does not happen automatically of course. There are exciting scientific challenges involved in processing the volume of data, dealing with the substantial variation in sports-related data, and handling the large volumes of data generated per unit time.

In the Netherlands we are well equipped to deal with these challenges. Data scientists who work with sports data have consolidated their strengths in the Sport Data Center, an open network in which Leiden University, Delft University of Technology and the AISS participate, for example. The Netherlands occupies an extremely strong international position in data science as was recently noted in the research visitation ICT (February 2016). The Netherlands is well connected



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with European data infrastructure initiatives such as FAIR data and the European open science cloud and participates in big data ecosystems such as SoBigData (EU project concerning European Research Infrastructure for Big Data and Social Mining).

Sport Data Valley: accessible data for everybody — With Sport Data Valley, an important new aspect of the sport science ecosystem, a start is being made with collecting and analysing data across different areas of expertise and practice. Sport Data Valley links data collections to experts who analyse the data to obtain new insights in a wide range of areas such as training load versus individual capacity, immunology or complete blood count analyses.

Involvement and knowledge sharing are vital — The value of insights and predictions that emerge from data science can only be assessed by the professionals who use these in practice. That requires the intensive involvement of athletes, coaches, trainers, movement scientists, physiotherapists, sports physicians, educationalists, power trainers, sports psychologists and nutrition experts. Outside of the field of sport it is important to make connections between sport-specific research and research in neighbouring domains, such as healthcare. Knowledge needs to be shared with general practitioners, medical specialists, and exercise and lifestyle advisers. And healthy and (chronically) ill individuals must be enabled to obtain useful information from the data as well.

Data stewardship and technology can be improved — The desired improvements in data stewardship (dealing carefully with data) are in the area of software and services for the reliable storage of data; safeguarding the quality of data; and ensuring future access to data for analysis. In the case of data technology it concerns reliable and scalable technologies for data storage and data analysis that are accessible for users such as athletes, coaches, clubs, scientists and companies.

3 — Improving Performance

Will the next Epke, Dafne, Sven or Ranomi stand up please?

*The way to the top is long and intensive and many hurdles must be overcome. New knowledge is needed to provide young talent with optimal coaching for future performances. Knowledge that arises through intensive collaboration between science and sports practice. In *Improving Performance*, the themes effective selection, learning, training and performing take centre stage with a crucial role for technology and data. Both able-bodied and disabled athletes can benefit from this. New knowledge can create a fertile ground for the next generation of top athletes!*

More medals require more scientific knowledge — Dutch elite sport wants to belong to the international top 10. We want to win more medals at an international level. Why? Because world-class sport performances give the Netherlands a positive international image. Top athletes can inspire each citizen to perform and to excel. And knowledge development and innovation in elite sports stimulate the knowledge economy.

However, more medals can only be obtained with more scientific knowledge. Knowledge about processes: about the physical and mental capabilities of athletes, and about the collaboration within teams and between athletes and coaches. And knowledge about materials: for sports like cycling, skating and sailing and for Paralympic sports, the characteristics of sports equipment are very important.



Elite sport revolves around continuous selection, development, learning, training and performance. To deliver top performances these processes must be carefully matched with each other and set up effectively. *Improving Performance* is therefore about improved effectiveness in sport. We distinguish four areas: effective selection and development of talented athletes; effective learning; effective training; and effective performance. Dutch sports scientists occupy an outstanding international position in these areas.

Effective selection and development of talented athletes — Talented top athletes must be selected at the right moment and according to the right criteria, with opportunities for intake and promotion for other sports. They must be able to develop optimally into potential medal winners. We must be able to determine their unique possibilities and competencies and identify the risk factors for dropout during their training trajectory.

Effective learning — Effective learning is about the learning style: role of observation and visual training; repetition versus differential learning; and the importance of instructions. Feedback is a vital aspect of being able to learn. Technical devices are increasingly playing an important role in this, such as cameras and goggles with displays that give real-time feedback. Such developments are also leading to a changing role for the coach.

Effective training — We can optimise training processes by developing effective training methods; by matching the training load to a person's capacity; and by taking the athlete's ability to recovery mentally and physically into account. Intensive competitions or competitions over several days in which athletes repeatedly have to peak in a short space of time, make recovery-promoting activities and measures even more important. Nutrition, sleep, the immune system and psychological and social factors also play a major role in effective training processes.

Effective performance — A top performance at the right moment starts with an optimal physical, mental and tactical preparation programme up until the start and, depending on the type of sport, with the right choice of material. During the competition, factors such as collaboration, strategy, coaching and a winner's mentality count. Innovative scientific developments and measurements can help athletes to optimise their preparations.

Exoskeletons and genetic profiles — It might be possible to train a top athlete's body to perform better by applying technological devices such as orthoses or exoskeletons to the body. These help to monitor training processes and, if necessary, to adjust these. For the monitoring of top athletes outside the training context, the use of technological devices for measuring recovery, nutritional patterns and sleep are also growing in importance. For top athletes it is increasingly possible to make individual training profiles by matching the performance with the effort provided. Individual measurements, analyses, interpretations and adjustment of top athletes are indispensable if Dutch athletes are to continue to perform at a high level in the future. In addition, the selection and training of talented top athletes will be helped with knowledge about genetic profiles.

4 — Exercising a lifetime, from 1 to 101

How can we ensure a fit society in which an active lifestyle is normal? A society where people take the stairs instead of the elevator, school pupils participate in sport and the chronically ill and elderly continue to exercise as well. Responsible participation in sport and exercise is healthy for young and old, sick and healthy, people with or without a disability. It reduces, for example, the risk of cardiovascular diseases, obesity and depression. Therefore knowledge is needed about the role of exercise in education, about individualised exercise programmes and about the prevention of injuries. Such knowledge will make it possible to encourage everybody in the Netherlands to exercise during their lifetime. From 1 to 101 years old, from the cradle to care homes and hospitals.

Exercise is only healthy if it is done responsibly — This theme first and foremost revolves around the relationship between exercise and health issues. Exercise has therefore been broadly defined: apart from encouraging sport and participation in exercise, research into physical education and, for example, dance also fall under this definition. Regular exercise and practising sport reduce, for example, the chances of cardiovascular diseases, obesity intestinal cancer, breast cancer, osteoporosis and depression. Insufficient exercise causes ten percent of mortality from non-transmittable diseases. But exercise is only healthy if it is done responsibly. *Exercising a lifetime* requires an education and exercise programme tailored to the individual; preventing the negative effects of sport; and knowledge about an improved health that benefits not just athletes but ill people as well.



The importance of individualised education and exercise programmes — To be able to meet the target of 70 percent of Dutch people complying with the Dutch Standard for Healthy Exercise in ten years' time, inactive people, trainers and administrators need to change their behaviour. We need to know how we can encourage an active lifestyle among all Dutch people – young and old, sick and healthy, poor and rich, able-bodied and disabled – and how we can keep people motivated to do this. Urban developments, technological devices, nutrition and mental factors all play a role in the connection between education and sport. For specific target groups – such as the elderly, the lower educated, secondary school pupils, people from ethnic minority groups, the chronically ill and people with a disability – individualised sport and exercise programmes can help them to start exercising.



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Preventing negative effects — Sport injuries have both social and economic consequences: medical treatments, time off school and work, loss of production. The prevention – and if necessary treatment – of health-related complaints concerns both the treatment of sport injuries and attention for overtraining, illness, sudden heart death and mental complaints. Dutch scientists are good in these subjects. They are carrying out research into the risk factors for health-related complaints; the social costs of sport injuries; the development and evaluation of preventative measures and therapeutic interventions; the improvement of cardiac and other screening techniques for athletes; and into the factors that are associated with a safe and successful return to the sports field.

Large cohort studies provide further benefits for both athletes and patients — New insights provide benefits that extend beyond sport. Large sport cohort studies, such as data collections at sports clubs and sports groups, can provide insights that help to realise an improved health and fitness. Athletes can benefit from that (for example prevention of injuries) but also people who suffer, for example, from stress, muscular diseases or obesity. Also the integration of sports data with data from medical cohort studies can give added value. And when it comes to health, we also need to know what the needs of inactive Dutch people are. Perhaps a different type of activity can tempt them to start exercising.

5 | The values of sport

Semra (15 years old, refugee), Pieter (14 years old, has a visual impairment) and Sara (21 years old, who grew up in a traditional Dutch family) speak each other's language and appreciate each other thanks to sport. How can we ensure that sport connects people, makes them stronger and supports the positive values in a changing society? At the same time sport is a part of society and a reflection of it. We therefore need more insight into the social opportunities and problems of sport, and more knowledge about the learning processes in sport and the effects of these in everyday life. With this knowledge we can encourage personal development and support social cohesion both with and through sport.



Sport and sport research are indispensable for tackling societal problems — Sport and exercise have a large potential value for tackling societal issues such as social cohesion, cultural diversity, safety, personal development, leadership, integrity, sustainability and the ability to innovate.

Research into the values of sport is developing rapidly throughout the world. The Netherlands occupies a leading position in this respect. Further investments in this area are therefore vitally important. Research into the values of sport can be divided into three thematic clusters: transition in sport; social opportunities and problems in sport; and learning processes in sport and physical education. Research themes at the interface of these clusters are particularly interesting.

Transition in sport: adapting to a changing environment — The success of sport organisations is not dependent on the number of members but on the value that they add to society. We must therefore adapt to a changing environment. For instance new reasons to participate in sport and new ways of connecting; new products, services and types of organisation; new business models for sport accommodations and sport events; innovation in types of public-private partnerships; increasing social media use; and social and technological innovations. An ongoing point of concern is also the relationship with and collaboration between the many – indispensable – volunteers in sport and the limited number of professionals.

An urgent question is how physical education, sport organisations, government bodies and industry can anticipate the transition that sport is undergoing. This question can only be answered if we have a clear view on the nature, size, experience and organisation of sport, as well as the factors that influence these developments: social and cultural factors, but also, for example, the influence of technology (including the digital media culture) and existing and new uses of public space.

Concrete research questions in this context are the price elasticity of participating in sport; the significance of technology and social media for practising sport and for supporters (clubs); the changing role of the sports club; the influence of the urban environment and landscape architecture on sport behaviour; the influence of the educational climate on the attractiveness of sport; and the influence of innovations in physical education on participation in the sport and exercise culture.

Social opportunities and problems: positive and negative effects of sport — We want to know which values and meanings sport and exercise have at an individual and collective level, and how the social context influences the world of sport. We also want to know how research into sport can contribute to solving societal issues within and outside of sport. This requires research into the positive and negative effects of sport.

Sport has economic value and impact but also positive social-psychological and social-societal effects. Examples are the personal development of children and young people; the empowerment of people with a disadvantage or disability; the development of neighbourhoods in problem districts; and the liveability of declining areas. We therefore want to know how sport and exercise activities can be matched to their context so as to optimise the benefit for both the individual and society.



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In sport, specific societal problems can find an outlet and be reinforced, such as provocative grunting behaviour. We can only increase and utilise the value of sport if we acquire a far better understanding of how sports activities can be set up, organised, supervised and managed in such a way that the negative societal effects and phenomena are prevented or reduced both within and outside of sport.



A historical and philosophical perspective can help in this regard. For example, research into diversity and differences in sport in the past and into the moral, normative, ethnic and religious dimensions of sport now. We also need to critically reflect on who can, may and want to participate in sport and who doesn't. We need to pose these same critical questions about the disciplinary and normative effect of an incentive policy with respect to sport and exercise.

Learning processes: physical, social and personal — More knowledge is needed about learning processes in sport and physical education. Knowledge about the effectiveness of interventions and any possible unintended side effects; about the acquisition of competencies as a result of which young people learn and continue to participate in sport and exercise; and about the implicit learning in the sport context, such as collaboration, punctuality, ability to follow rules, physicality and personal development.

The theme 'The values of sport' also concerns the effects of processes of learning and change outside of sport. For example, the significance of sport and exercise for motor, cognitive and socio-emotional learning processes and performances, and the use of role models in elite sports to encourage young people to change their behaviour. In addition research, into implicit learning processes in and via sport is important – for example about gender, personality and physicality – and into the effects of this outside of the sports field. As adults play an important role in such learning processes among young people, an analysis is also needed into their influence on this and into the organisational context in which these learning processes take place.

The cluster 'Learning processes' also focuses on the effectiveness of interventions, such as the use of sports projects to strengthen social cohesion in rapidly changing districts. To discover if such interventions really work more research is needed into their unintended side effects.

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