CITIUS ALTIUS FORTIUS

ABOUT THE FUTURE OF SPORTS, PHYSICAL ACTIVITY & HEALTH

Mr Rector Magnificus, ladies and gentlemen, with great pleasure and pride, I accept the position of Professor of Epidemiology of Sport, Exercise and Health this afternoon. In the next 40 minutes, I will give you an outline of my vision of the past, the present and the future of Sport, Exercise and Health at the Department of Public and Occupational Health of the VUmc, in collaboration with various partners. My main message will be that our knowledge and expertise only covers a limited part of a complex whole and that a joint and integrated approach is required to come to effective solutions. Before I come to this message, I will talk about the relationship between exercise and sport on the one hand, and the health of the individual and public health on the other side. I will discuss both the advantages and the disadvantages of physical activity. I will present my vision on solutions related to physical activity problems, which will be investigated and carried out under my responsibility in the coming years. I will also briefly discuss the importance of structural collaboration between research, care and practice in both research and education.

CITIUS, ALTIUS, FORTIUS

The Olympic thought

But first of all, I want to take you to the title of this speech 'Citius, Altius, Fortius: about the future of Sport, Exercise and Health'. In the title, references are hidden to both the past, the present, and the future of the subject of my chair. The words Citius, Altius and Fortius are inseparable with the Olympics. Faster, Higher, Stronger. These three words - originally conceived by Henri Didon, a French monk and a great champion of youth sport - were taken by Pierre de Coubertin in 1894 as the motto for the establishment of the International Olympic Committee. Over the years, these words have gained significance in the context of elite sports. A meaning that differs from the original idea with which the Olympic Movement was conceived a century ago. It is the original thought that I would like to draw your attention to. Faster, higher, stronger is not about defeating your opponent and doing everything to prevail; these words stand for individual self-improvement through exercise and sport; physically and socially, intellectually, aesthetically and morally. Not just the final result counts, but personal commitment and active participation in exercise and sports.

Everyone is an athlete
In this original idea, every individual - from the immobile patient to the Olympic athlete and everyone in between - is an athlete. All of us; everyone, with their characteristics and goals to be achieved through exercise and sports. Each with our unique ability to perform within the limits of our capacities and possibilities. For some patients, the road from bed to the toilet is already a substantial physical effort. An achievement that is not inferior to the effort of a Sven Kramer skating a golden race. This comparison illustrates how I view the meaning of physical activity and sports for society, and how I have researched these subjects in my research over the recent years. Research into the relationship between sport, exercise and health is in my view well connected with the challenges we face in our contemporary society regarding health. I want to take you along some of these challenges.

(NOT) MOVING & PUBLIC HEALTH

Lifestyle-related disorders

The disease burden due to lifestyle-related disorders - also called chronic diseases - has increased in recent years [2-3]. The World Health Organization estimates that each year 40 million people die as a result of such conditions [4]. This corresponds approximately to 70% of all premature deaths worldwide. This mainly concerns cardiovascular diseases, certain types of cancer, type II diabetes and chronic respiratory diseases. These are for the most part acquired diseases; that is, disorders that develop in the course of our lives, partly because of unhealthy lifestyle habits. Where this used to affect elderly mainly, nowadays one-third of the deaths from these disorders are found in the 30 to 70 years old population [4]. We are dealing with a still growing social problem. Worldwide, 6% to 10% of lifestyle-related disorders are caused by inadequate physical activity, and around 5 million people die each year due to a lack of physical activity. Compared with other unhealthy lifestyle habits that directly contribute to this health problem, physical inactivity - based on these figures - is at least on an equal level with smoking [5].

A healthy amount of physical activity

A daily dose of exercise and frequent participation in sport are irrefutably associated with the health of the individual and have an important impact on public health [6-10]. In the past, the recommendations regarding the minimum amount and intensity of exercise which one must obtain to enjoy the health benefits were described by the Health Council in the Dutch norm for healthy exercise [11]. Last year an update of these advices appeared in the Physical Activity Directives [12]. These renewed guidelines are stricter than the previous Dutch Healthy Exercise Standards. For young people, at the moment the advice is at least one hour of moderate
intensity exercise every day. For adults and the elderly, at least 150 minutes a week applies to moderate intensity exercises, such as walking and cycling. Also, it is stated:

- Exercise is good; more exercise is better;
- Longer, more frequent and/or more intensive exercise than advised has additional health benefits;
- Do muscle and bone strengthening activities at least twice a week, for the elderly combined with balance exercises, and;
- Avoid sitting.

**Are we active enough?**

How good are we in the Netherlands in following this advice? There is still a lot to be gained here. Just under half of all Dutch people comply with the Physical Activity Directives. A percentage that is virtually stable since 2014 \[13\]. However, we must not ignore the fact that here there are major differences between different groups in the Dutch population. Where about 55% of youth up to 11 years still achieve the exercise standards, this - shockingly - drops to a quarter of young people between the ages of 12 and 17! It then crawls up again, but you must take note that these present so-called cross-sectional data; these numbers only give a snapshot of the current situation. Moreover, it is still questionable whether inactive adolescents start to move again as they age. Inadequate physical activity during this period of development also has far-reaching negative consequences for health in later life. I cannot draw any other conclusions from this than that we do not exercise enough in the Netherlands. I, therefore, dare to state that the health of Dutch society is currently under heavy pressure due to a collective lack of physical activity.

**Now what?**

Action is needed. However, if there is something that we have learned from the past, it is that activating and motivating individuals to move more is a huge challenge. Exercise is behaviour, and until recently physical activity - like other forms of behaviour – was seen as an expression of conscious choices we make under the influence of determinants\[14-18\]. Interventions therefore often focused on influencing these determinants, resulting in little to no lasting effects of our intervention efforts. It is now clear that most of our behaviour manifests itself in an unconscious response to our social and physical environment \[19-21\]. As my mentor, Professor Willem van Mechelen, always says: "Man does not exhibit abnormal behaviour in a normal environment. Man exhibits normal behaviour in response to an abnormal environment ". This requires a paradigm change and with it a different way of intervening. New innovative approaches that
our research group studies. I would like to highlight three of such projects from our research group briefly.

**PlayGrounds**

PlayGrounds is a project in which we have tackled the schoolyards of primary schools. In the physical education classes, we paid attention to exercise, and the children were offered various active forms of play. Also, the layout of the schoolyards was adapted, and materials were provided to be able to carry out the learned forms of play in the schoolyard. It turned out that during the school breaks, the children moved more actively with pleasure, and without further intervention. Mirka Janssen received her doctorate in 2014 on this project and also received the prestigious Public Health Prize for this.

**EuroFit**

The EuroFIT project funded by the EU is being carried out in the Netherlands by Femke van Nassau and Judith Jelsma, under the supervision of Hidde van der Ploeg. This project specifically uses elite sports as an intervention setting. EuroFIT is a lifestyle program that is based on state-of-the-art theory and evidence. It uses new technology. Unique to this program is that European professional football clubs offer it to their male fans. Fifteen clubs from England, Portugal, Norway and the Netherlands - ADO Den Haag, FC Groningen, PSV, Vitesse and Heerenveen - take part in the study and carry out the EuroFIT program. The research on the program has not yet been completed, but the previous results in Scotland showed an average of 5 kilograms of weight reduction compared to the control group, and our first analyses are also encouraging.

**Power to the People**

The last project that I want to mention here has started recently, in collaboration with the research line Quality, Risk & Safety in Healthcare of our department. In the Power to the People project, we are looking for effective components of ‘nudging’ to change the physical activity behaviour of the individual permanently. Nudging is a behavioural, psychological motivation technique, whereby the environment is adjusted so that the individual automatically finds the 'good' - in this case the 'healthy' - choice more attractive. A well-known example of nudging is the placement of a fake fly on the urinals so that men no longer pee outside the
pot. In the coming years, Lorraine Landais will investigate whether and how this technique can be used effectively to stimulate exercise.

EXERCISE AS MEDICINE

In my speech, I have so far dealt with exercise as a means of primary prevention of health complaints. However, exercise can also be used curatively as 'medicine' and for some disorders provides an equally good treatment alternative to traditional medical treatment [28-31]. To date, in our line of research Exercise, Medicine has not yet been given structural attention, but more effort will be put on this in the coming years.

Currently, we complete, for example, in collaboration with Christa Boer of the Department of Anesthesiology at the University Medical Center, the Positive study. We screened patients at the outpatient clinic 'pre-operative screening' for metabolic syndrome and diabetes; these are risk factors for postoperative complications. These risk factors were found in more than half of the patients who were overweight without being aware of this themselves. These patients benefit pre-operatively from lifestyle advice, in which more exercise plays a pivotal role. Floris van Raalten hopes to defend his PhD thesis on these data by next year.

Also, in collaboration with UMC Groningen, the ZonMw-funded 'Physicians Implement Exercise is Medicine' project has started, with the aim to strengthen Exercise as medicine in clinical care. This project seeks to break down barriers that clinicians experience when advising exercise to their patients. A guideline will also be developed to support the clinician in motivating and inspiring patients to exercise more.

HEALTHY MOVING AND SPORTS

A daily dose of activity is healthy, but...

So far I have discussed the health gain that can be achieved with physical activity, both preventive and curative. I assume that you no longer doubt the great importance of exercise for our health, but all that exercise also requires a marginal note. One of the side effects of exercise and sports is the risk of injury. Let me state upfront that this negative outcome does not weigh against the major health gains we can achieve individually and collectively by sufficient exercise. However, we cannot just slide the short and long-term effects of sports injuries under the carpet. If we see exercise as a medicine, we also should make sure that we know about the potential side-effects and manage these [32]. Moreover, injuries caused by exercise and sport have a significant share in our total burden of disease. In the EU, for example, the annual total number of acute injuries caused by exercise and sport is estimated at
300 million \[35\]. The social impact of this number is underlined by the estimated annual costs of € 78 billion as a result of these injuries; 7.8% of total healthcare costs in the EU \[34\]. For comparison:

- Every year, around 21 million EU citizens suffer from depressive symptoms that cost the European society around € 118 billion;
- Dementia affects in the EU annually around 10 million people and cost us around € 170 billion; and
- 84 million people with diabetes cost the EU annually € 90 billion.

With the contemporary focus and commitment to make our population more active - assuming that we will succeed - we can only expect an increase in the burden of disease due to injuries. Action is therefore also required here.

**Sports injuries in the Netherlands**

Dutch figures on sports injuries illustrate the problem that I just outlined. The survey into Injuries and Physical Activity in Netherlands - OBIN - was an annual population survey conducted to track injuries and accidents due to, amongst others, sports participation in the Netherlands. The latest available figures from 2013 show that there were 4.5 million injuries annually among Dutch athletes \[35\]. This was a considerable increase compared to 2008 when this number was considerably lower with 3.7 million injuries. I can hear you thinking ", but maybe more people are exercising?!" After all, more athletes also means more injuries. But even if we correct the number of injuries for the number of hours during which sports are carried out - the incidence density - we still find a steady increase over the years in this corrected injury risk \[35\].

However, you are also right; indeed more people have started to exercise. In 2009 there were - according to OBIN - about 11 million Dutch athletes. In 2013, this number had increased to 16 million. These are large numbers, which do not correspond to the earlier figures I mentioned about the low percentage of Dutch people who comply with the Physical Activity Directives \[13\]. OBIN used a broad definition of the term "athlete" and defined this as "one who participates in a sporting activity at least once per month." You can, of course, raise your doubts about such a broad definition, but other sources also endorse an increase in the number of Dutch athletes. The NOC*NSF, for example, estimates that in 2016 on average 61% of the Dutch participated in sports at least once a week. This corresponds to almost 9.5 million Dutch, one million more than in 2013 \[36\]. This increase can mainly be explained by a jump in the number of fitness goers and runners. These are precisely also the sports that are easily accessible, and people engage in to do to ‘something’ about their health. Something good happens somewhere, and more people
are drawn to these healthy activities. Now there is just the crux concerning sports injuries and the increasing burden of disease.

**Health benefits versus health risks**

Ilkka Vuori from Finland presented a conceptual model two decades ago, in which the health gains from exercise and sport are compared with the health risks. This model describes a continuum of types of physical activities and intensities; from light intensive daily activities, via the physical activity guidelines, to intensive sports participation. The gain of health through movement increases – in theory - exponentially for almost all organ systems as the exercise intensity increases and eventually levels off. However, the health risks only increase appreciably with higher exercise intensities. The question is, however, whether this theoretical model also fits reality. If we change the physical activity intensities of this model into runners, we can create a range from novice runners, through recreational and competitive runners, to marathon runners. In 2010, we summarised the risk of running injuries from the literature, and we calculated the risk of injury for each of said groups; expressed in the number of injuries per 1,000 hours of running [37]. According to this analysis, marathon runners have 1.10 injuries per 1,000 hours of running, followed by competitive runners with 1.55 injuries per 1,000 hours, female and male recreational runners with 1.80 and 2.06 injuries per 1,000 hours respectively, and eventually novice runners with 2.56 injuries per 1,000 running hours. The conclusion is that with increasing running exposure, the risk of injury decreases. We also found similar outcomes for 10 to 12-year-old children in the iPlay study [38]. The least active children were found to have a higher risk of injury, compared to the more active children. In short, the inactive target groups that we try to enthuse to move more and to participate in sports, are also the most vulnerable to the potential negative consequences. This fact, together with the previously presented annual increase in injuries, suggests that the current preventive approach is insufficient.

**Now what?**

I see two main reasons why our efforts to date have not yet shown enough effect for the athlete:

1) insufficient funds and lack of continuity of funding for research and development; and
2) a lack of external validity of research results.

*Continuity and amount of research funding*
The theme of sports injury prevention is on the agenda of policymakers and subsidy providers. Over the years it has become apparent that injuries through exercise and sports are a huge social burden, as I have also just described. This awareness has facilitated the beginning of my academic career. The Ministry of VWS invested heavily in infrastructure for research into Sport, Exercise and Health. This resulted in the LOSO network; a research collaboration between the academic medical centres VUmc, UMC Utrecht, UMC Groningen, UMC Maastricht and later also ErasmusMC. Each of these partners has been able to strengthen their expertise within this infrastructure and to support promising researchers. We can now reap the benefits of this if it were not for the financial resources that are declining. As an example, I mention here the current program sports injury prevention of ZonMw. Within this program, only €1.4 million is available for the next two years. This is too little and inefficient.

Our line of research into ankle injuries shows that investment in sports injury prevention is worthwhile. Ankle injuries are the most common injuries within sport. Approximately one-quarter of all sports injuries are to the ankle and in 2013 680,000 Dutch athletes suffered this injury. My PhD project - which I completed in 2004 - dealt with the question of how we can prevent these injuries within sport. Employing a primary preventive exercise program developed and evaluated in Dutch volleyball, we found a 50% decrease in the number of ankle sprains. However, we found the strongest effect on players who previously had suffered such an injury. Maarten Hupperets continued with this fact, and we incorporated a training program as secondary preventive advice after treatment. Here too we found a halving of the number of injuries. Moreover, this project showed that an investment of €27.50 in intervention costs per athlete led €150 gain due to lower direct and indirect social costs; a return on investment of 1 in 5.5. Simply achieved through less and less severe injuries. However, it turned out that the compliance - this is the way in which and the extent to which the athletes followed our preventive advice - was not optimal. So much profit could still be gained here. Kasper Janssen, therefore, continued with the question whether braces or our exercise program should be advised. Braces proved to be more effective here when looking at the prevention of secondary injuries, but the results also appeared to depend on the preference of the user; for brace or exercises. VeiligheidNL has included the lessons learned from the studies mentioned in the Versterk je Enkel mobile app, which has been tested for effectiveness in recent years by Miriam van Reijen. In short, a line of successive projects that build on each other.

My question, however, was whether this investment in research has been worth its money. For this, I need to bother you with some figures. Since 2000, a total of approximately €950,000 research budget has been allocated to these four projects. We know from our studies that an ankle injury costs around 350€. If the results of our projects have prevented 2,700 injuries over the years, then the investment based on the injury costs is already recouped. However, I dare to think bigger. It always takes some time before research results also result in an effect in practice, so let us take conservatively into our minds only the last ten years. A period of 10 years
with 680,000 ankle sprains per year. This gives an estimated cost of € 2.3 billion due to injuries to the ankle. With the outlined 50% injury reduction as found in the projects mentioned above, there is no need to explain further that the research budgets awarded - on paper - have yielded a huge return on investment. In short; research and investment in sports injury prevention pays off!

Lack of external validity

However, we do not solve the problem of sports injury problems only with more funding for research. It is also important to bring our preventive knowledge better to the athlete; implementation. Beautiful research results are of little value if the athlete cannot or does not want to use them [54-57]. Here it still goes wrong too often [54,58]. In recent years a wealth of knowledge has been accumulated from the approach described in 1992 by Willem van Mechelen, Hynek Hlobil and Han Kemper in the "Sequence of Prevention" [59]. This cycle describes four consecutive steps that can be followed to develop an effective solution to an injury problem. Later, two extra steps were added by Caroline Finch, in which attention is paid to the implementation of effective interventions [60]. Both models are on the basis of almost all research conducted on injury prevention in sport, and we now have the basic elements to build the 'perfect' intervention. We must, however, bear in mind that this knowledge comes from studies that have been carried out to a greater or lesser extent in a controlled setting. The internal validity of these studies may be high, but the external validity - i.e. the generalizability – is not always guaranteed. Research results do not translate 1-to-1 into the context of the athlete. We do not completely solve this 'translation gap', but optimisation is certainly possible here. We recently started working on this in two ways.

Luiz Hespanhol has followed the health of runners in time through in the Running for Health project [61]. Runners were weekly asked if they developed health complaints through running, as well as the nature and extent of the complaints. Half of the research group received general advice on the prevention of running injuries at the start of the study. The other half received this general advice too, but also - in the case of a reported complaint - personal advice on what to do in the next week. The group with the personal advice followed the given advices better than the control group who received standard advice, which resulted in 13% fewer injuries [61]. Saulo Delfino Barboza continued this method by translating this system into a health monitoring system in which various groups of athletes, from recreational sports to elite sport, are currently being followed and provided with feedback on a weekly basis [62,63]. The knowledge gained in these projects is now being incorporated into the research program 'Citius, Altius Sanius' recently awarded by NWO / STW. This project entails collaboration between universities, hospitals, sports organisations and business. The central question is how do you get and keep people exercising, and prevent them from being injured? Within this program, new sensors will be developed in the coming years to measure the physical and physiological
load of the athlete; data science will be used to calculate the injury risk for the individual athlete and personalised feedback methods will be used to influence the behaviour of athletes of any level of performance.

What we must not forget in all this is the athlete himself, in his or her context. To date, our knowledge about sports injury prevention has mainly been developed from a biomedical point of view in which the injury is the central point of attention. In this biomedical paradigm, we ignore the fact that an injury occurs within an individual, but that behaviour and environment also influence the onset, course and experience of injuries; a biopsychosocial approach is therefore needed[64,65]. An injury, for example, has a completely different impact on an elite athlete who receives the best possible care immediately, compared with an amateur athlete who has to search for information and possible care. Caroline Bolling recently started a project that focuses on this issue. Using a qualitative approach, she maps out how athletes from various backgrounds look at injuries and injury prevention. The full results are expected within a year, but a first look at the outcomes show clear differences between beginning and experienced athletes. These outcomes will also give direction to how we in the Netherlands should approach the athlete better with our scientific knowledge.

**COLLABORATE IN FUTURE RESEARCH AND EDUCATION**

I have given you here a sketch of my view on the past, present and future of research into Sport, Exercise and Health in the Netherlands. Over the years, we have built up a wealth of knowledge and expertise through our research on the epidemiology of the problems mentioned. However, this knowledge only bridges a limited part of a complex whole. To arrive at an effective solution, a joint and integrated approach is required. We will have to invest in structural partnerships in the coming years to utilise our collective knowledge. At local, national, but also international level. The already described LOSO network is a characteristic example of how various academic partners can work together effectively and in combination can deliver more than the sum of parts.

Locally, in Amsterdam, we have set up a network in collaboration with the Department of Orthopedics at the AMC. This collaboration links our knowledge in the field of sports injury prevention with the clinical sports medicine provided by the AMC. Overarching we have in this way cooperation that connects the forces on both sides of the Amstel; from primary prevention, through effective treatment, to secondary prevention and return to sport. This combination has been endorsed by the International Olympic Committee (IOC) and is recognised as one of the ten worldwide accredited research centres in the field of protection and care for athlete health. This collaboration will only be strengthened by the alliance and the forthcoming merger between VUmc and AMC. I will say Citius, Altius, Fortius.
In Amsterdam there is also a broader collaboration in the Amsterdam Institute of Sport Sciences (AISS); a network where research, education, care and sports practice meet. Research is carried out within the practical sports context by 'embedded scientists' and education also takes place in this sports practice. The AISS provides a dynamic environment, where performance and vitality within sport - from recreational to elite - meet and were new questions and insights are being developed at the interface of science and practice. All this will be brought together in the Amsterdam Performance & Health Center (APHC) soon. This will be a physical location on the VU campus, where all these elements will come together and where both patients and elite athletes can go for care and advice.

In all this, we cannot do without embedding mentioned subjects in education. In the basic medical curriculum of VU University Amsterdam, increasing attention is being paid to knowledge about Sport, Exercise and Health from a clinical perspective. Within the 'Lifestyle & Medical Interventions' course, lectures and working groups are provided by our research group. Also, a course on Sport and Health is offered within the optional Bachelor program. Finally, attention is paid to our subjects within the master courses of Movement and Health Sciences through lectures and internships. We intend to strengthen this embedding in the coming years further.

I have said.

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