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## Sport as a medicine for health and health inequalities

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# Chapter | 1 |

## Chapter 1. Introduction

In the beginning of the 20<sup>th</sup> century, the great economist John Maynard Keynes based his ideas of economics on the notion that it should be possible for any man to pursue ‘the good life’ (Keynes, 1973). Some 2300 years earlier, Greek philosopher Aristotle noted that ‘the state comes into existence for the sake of life and continues to exist for the sake of good life’ (Ameriks & Clarke, 2000). Naturally, the question of what this ‘good life’ consists of is a philosophical one, just as it is a personal one, and continues to be debated. Keynes and Aristotle saw the good life as a moral concept of a life that is worth being lived and has virtues, such as honour, wisdom and pleasure (Carabelli & Cedrini, 2018). Both Keynes and Aristotle believed that to achieve the good life, it requires a basic level of material needs (Carabelli & Cedrini, 2018). As such, economic activities can be seen as just the means to an end: the good life. According to Keynes, the task of economists should be to investigate the economic dynamics and conditions for the good life. He believed that the government should play an important role to supply these preconditions, since the market fails to deliver many of the social goods that make life meaningful, including ‘parks, squares, playgrounds (...) and every delight which skill and fancy can device’ (Keynes, 1973). For Keynes personally, the good life consisted to a considerable extent of enjoying the arts (Carter, 2021). Being part of the Bloomsbury group, that included writer Virginia Woolf and painter (and his occasional lover) Duncan Grant, Keynes collected paintings, frequented theatres and he became intoxicated by ballet, when he saw a performance of Tchaikovsky’s *Sleeping Beauty*, starring his future wife Lydia Lopokova (Carter, 2021). Today, for many people the good life consists to a considerable extent of a whole set of leisure time activities, including enjoying the arts, but also gardening, playing video games or practicing or spectating sport.

Although linking Keynes and Keynesian economics to leisure, sport and health seem a little far-fetched at first, his philosophical idea of ‘the good life’ may be a good frame for understanding the current-day aims and actions of individuals, groups and societies. In the times of Keynes (early 20<sup>th</sup> century), sport was a niche but upcoming leisure activity for mainly the well-to-do. Since then, living standards have improved, leisure time increased and sport transformed to an integral part of the whole society (Coalter, 2007). Today, many people spend a considerable amount of time and money on practicing or watching sport. As a result, some sport leagues (such as the Premier League Football, National Basketball Association, National Football League and Major League Baseball) have become multi-billion enterprises (Bradbury, 2019). In the Netherlands alone, sport-related expenditure is around

€15 billion per year and the total value added of the complete Dutch sport sector is €7 billion, or 1.0% of GDP (CBS, 2019a). The organizational aspects of professional sports have been intensively researched by sport economists, the literature on the economic and social aspects of participation sport has been relatively limited. At the same time, from a public health perspective, sport participation has often been regarded as merely a form of physical activity.

The effects of physical activity in general on health outcomes have been researched quite extensively. Physical activity has been a proven contributor to a longer life, as well as to the quality of life (Anderson et al, 2000; Jeon et al., 2007). Although sport participation is seen as an important - among children possibly even a key - way to stimulate physical activity and thus to promote health (Krustrup, Dvorak and Bangsbo, 2016), research on the health effects of sport participation, and specific aspects thereof, has been relatively limited, compared to those for physical activity in general. This is surprising, given the substantial public and private investments in sport. In the Netherlands government direct and indirect spending on sport is around €3.5 billion annually (CBS, 2019). However, this number is just a fraction of public spending on health care, which adds up to over €80 billion annually (VWS, 2020). Indeed, containing the costs of health care has become a major objective for many governments, with sport and physical activity increasingly being seen as potential means to this end.

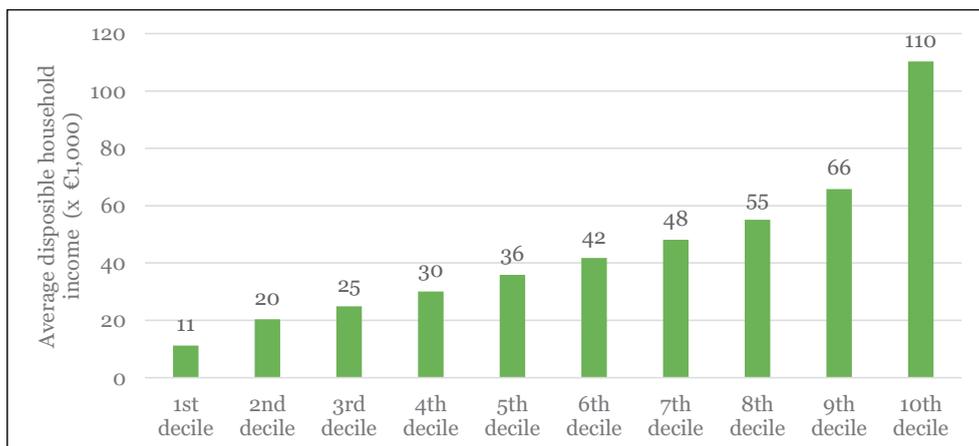
There are many questions about the relationship between sport and public health in terms of possible health benefits of sport participation as well as its potential to contain health care costs. The objective of this thesis is to provide some fundamental insights on the role of sport participation in public health. We will investigate the relationship between sport participation and health outcomes, such as mortality and the incidence of diabetes. Since health is distributed very unequally across different subpopulations (with for example a low socioeconomic status being associated with relative poorer health and lower life expectancy), we are also investigating which role sport participation plays with regard to health inequalities. In this thesis the term *health inequality* refers to differences in health between individuals or groups. According to Kawachi, Subramanian and Almeida-Filho (2002), any measurable aspect of health that varies across any socially relevant groups or can be called a health inequality. Furthermore, we investigate to what extent there are socioeconomic differences in health care costs and to what extent sport and physical activity play a role in these differences.

Before presenting the research of this thesis, this chapter gives some context on the major themes of this thesis. We start with providing background information on socioeconomic inequalities (1.1), health (1.2), health care costs (1.3) and physical activity and sport participation (1.4). This will then lead to the rationale for the main research questions of this thesis (1.5). Finally, this chapter will end with an outline of the following chapters (1.6).

## 1.1 Socioeconomic inequalities

Keynes envisioned a world in which it would be possible for anyone to enjoy the good life (Keynes, 1973). Since the death of Keynes in 1946, the world has seen unprecedented economic growth in the 75 years that followed. In many countries the standard of living has increased enormously, and for many individuals the good life has materialized, although not often with a 15-hour work week, as Keynes famously predicted in 1930 (Keynes, 1973). Since 1950, real economic growth (at Gross Domestic Product per capita, corrected for purchasing power parity), has been around 400% for the Netherlands and 350% for the world (Bolt & Van Zanden, 2020). However, the new prosperity is not universal. While in East Asia average GDP per capita is now more 14-fold the 1950-level, Sub-Sahara Africa, experienced only a modest growth of 250% over that same period (Bolt & Van Zanden, 2020). Not only between, but also within countries, large socioeconomic inequalities exist. Figure 1.1 shows the distribution of the disposable household income in the Netherlands. The decile (10% of the households) with the lowest incomes have an average disposable income of around € 11,000. This amount is on average ten times larger for the 10% highest earners. This inequality is relatively modest compared to other countries, due to a relatively large governmental redistribution of income. Government benefits for, among others, unemployment, disabilities and old age, are important reasons why the Netherlands has one of the most equal distributions of income in the developed world. The Gini coefficient, which measures the inequality of a certain distribution on a scale of 0 (perfect equality) to 1 (maximum inequality), is around 0.3 for disposable income in the Netherlands.

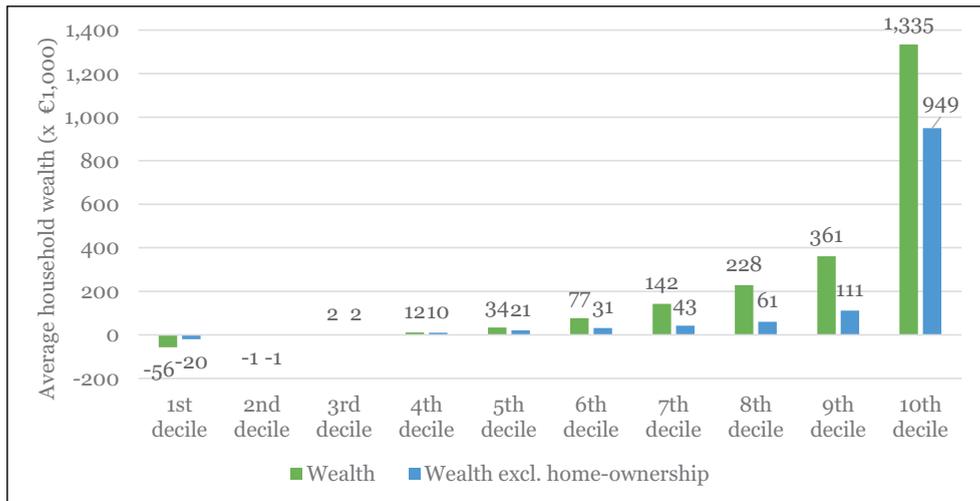
**Figure 1.1 Distribution of disposable household income in the Netherlands (2019)**



Source: CBS (2020)

While income inequalities in the Netherlands have been relatively small and more or less stable in recent decades, the distribution of wealth tells a different story. According to Van Bavel and Frankema (2015) the Gini coefficient of private wealth inequality ranges between 0.8 to 0.9, which is high, even in comparison with other developed countries. Table 1.2 shows the distribution of net wealth including and excluding home-ownership. While the ‘poorest’ half of the country have a combined wealth that is neglectable, or - when home-ownership is included – negative, the richest ten percent of households have almost one million euros of net wealth each, or over 1.3 million euros when home-ownership is included.

**Figure 1.2 Distribution of net wealth in the Netherlands (2019)**



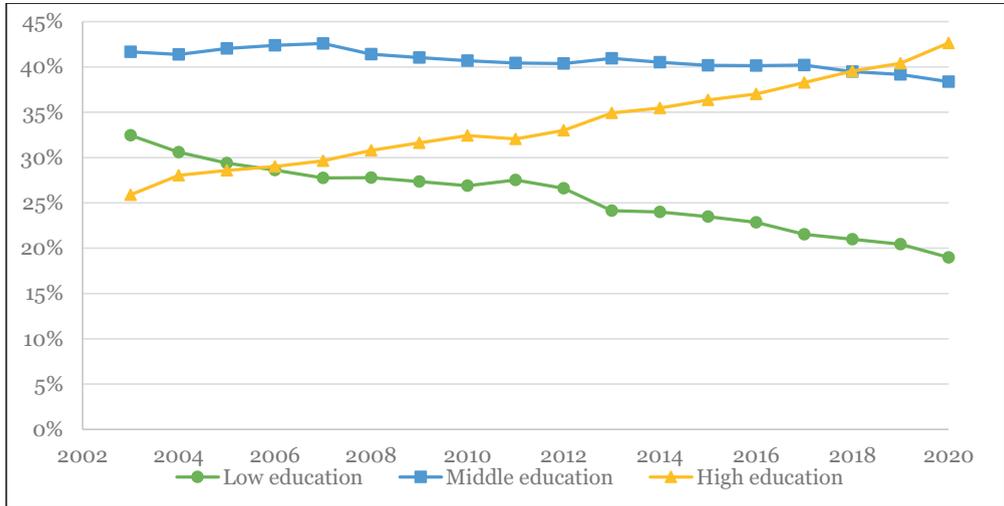
Source: CBS (2021a)

Income inequality in the Netherlands has been more or less stable since the beginning of the century, while many other developed countries have seen a (slight) increase in income inequality. To some extent the combination of a relatively equal distribution of income and a healthy economic growth rate can be explained by a shift in educational level. In the Netherlands, the fraction of the population that has completed higher education has steadily increased over the last decades (Figure 1.3). Currently, among individuals aged 25 to 65, high educated (i.e. persons with a degree in higher vocational or scientific education) are the largest group. Their share has increased from around 25% in 2003 to over 40% in 2020. Over the same period the share of the low educated (i.e. persons with only primary education or preparatory secondary vocational education or lower vocational education as their highest finished educational level) dropped from one in three adults to less than one in five.

There are many societal effects of both the economic growth and the socioeconomic inequalities that are described above. These include personal development, morality and

delinquency (Robert & House, 2000). We will now turn our attention to another topic that is also one of the most important products of an unequal distribution of income and wealth: inequalities in health and well-being (Marmot, 2003).

**Figure 1.3 Development of educational levels in the Netherlands among 25-65 year-olds (2003-2020)**

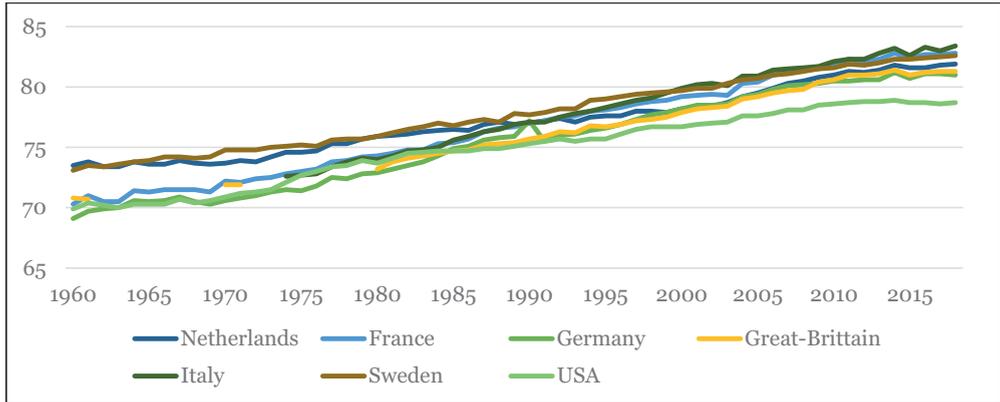


Source: CBS (2021b). Educational level refers to an individual's highest completed educational level. Low education is primary education or preparatory secondary vocational education or lower vocational education as their highest finished educational level. Middle education is higher secondary education or middle vocational education. Higher education is higher vocational education or university.

## 1.2 Socioeconomic inequalities in health

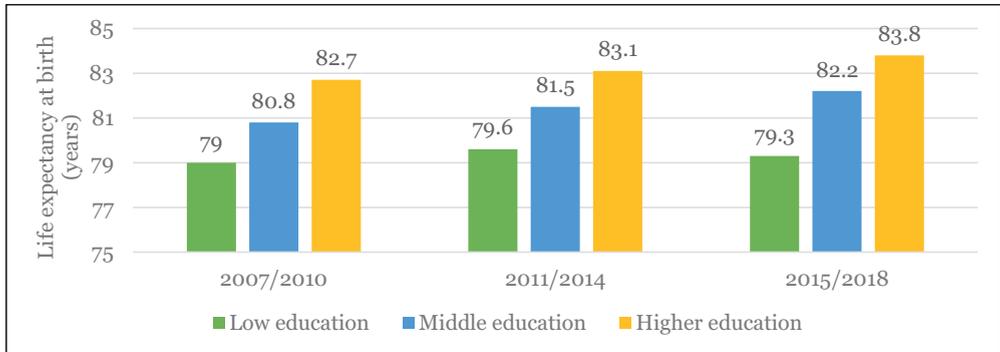
In the past centuries, living conditions and medical knowledge have improved enormously. As a result, health has improved considerably, for populations worldwide. For instance, since 1960, the average life expectancy in many Western European countries has increased from around 70 years to over 80 years (see fig. 1.4). However, not every individual profits equally from these health improvements. The socioeconomic differences discussed in the section above have also had an effect on the distribution of health. For example, the life expectancy for residents of poor countries is much shorter than for residents of wealthy countries (Marmot, 2015). There are also major health inequalities within countries that are related to socioeconomic inequalities. In the Netherlands, average life expectancy for the lower educated is 79.3 years, while it is 4.5 years higher for the higher educated (Figure 1.5). A similar gradient can be observed for income levels, with the lowest income group having a life expectancy that is even seven years lower than for high income groups (Figure 1.6). Moreover, there is no indication that these socioeconomic health inequalities are narrowing.

**Figure 1.4 Life expectancy at birth, selected countries (1960-2018)**



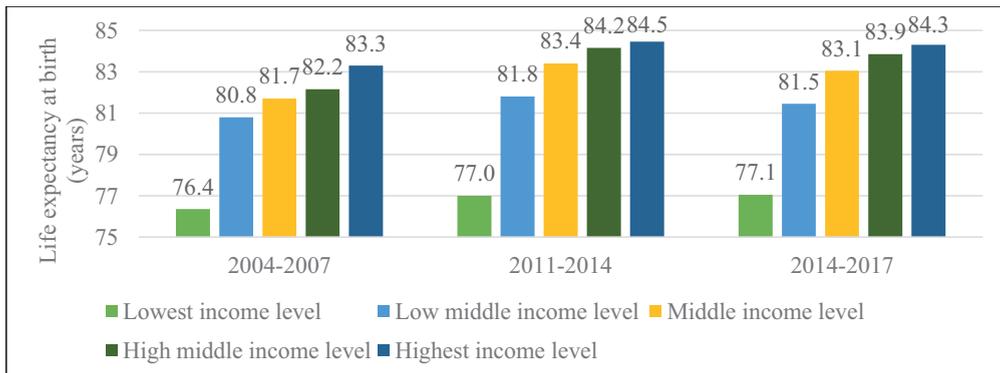
Source: OECD (2021).

**Figure 1.5 Life expectancy at birth in the Netherlands, by educational level (2007-2018)**



Source: CBS (2019b).

**Figure 1.6 Life expectancy at birth in the Netherlands, by income level (2004-2017)**



Source: CBS (2019c). Income levels defined by standardized disposable household income distribution in quintiles (i.e. Lowest income level is lowest 20% disposable household incomes).

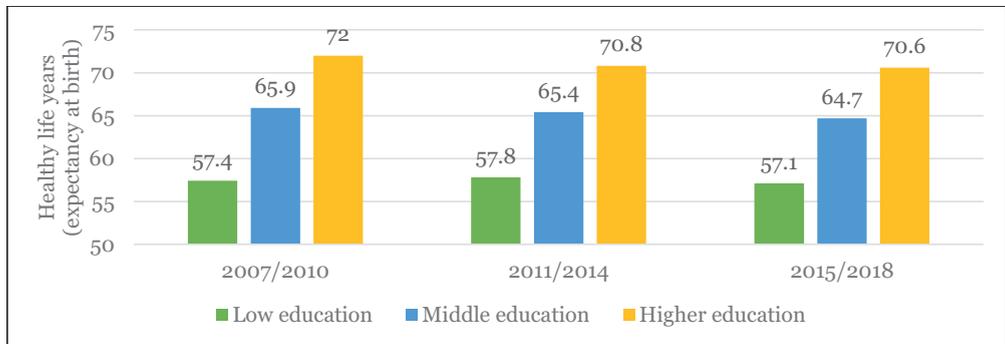
When comparing health statuses over the life span, socioeconomic differences are even greater. Healthy life years expectancy is the number of years that an individual of a certain age is expected to live in good health, defined as the absence of reports of chronic diseases or physical disabilities or as good perceived physical and psychological health (Hyder, Rotlland & Morrow, 1998). Figures 1.7 and 1.8 show the expected healthy life years at birth, defined by good perceived health, by education and income level, respectively. There is a difference of 13.5 healthy life years between the lowest and highest education level in the Netherlands. An individual from the lowest income group will expect to have 20 years less years in a good health condition than someone from the highest income category. In recent decades, these differences seems to be increasing rather than decreasing. So, despite the fact that the Netherlands has a relatively equal income distribution and a large social security system, large differences exist in health outcomes (Mackenbach & Stronks, 2002).

In recent decades, the attention for health inequalities has increased substantially. These inequalities are not simply a matter of income or wealth, nor are they just individual choices. According to Lahelma et al. (2004), education, occupational class and income are partially independent and partially inter-dependent determinants of health. Moreover, for someone with a low-socioeconomic status, the chances are relatively high that he or she is doing physically demanding work, living in poorer housing or running into debt (Marmot, 2005). These circumstances, in turn, may cause uncertainty, stress, limited self-esteem and less self-reliance (Marmot, 2015). In addition, low literacy plays a hindering role in, for example, developing a healthy lifestyle or finding the way to (preventive) health care. In addition, healthy, as well as unhealthy, habits are often passed on from parents to children (Adler, 1999). A parent's nutrition and physical activity pattern is often a good predictor of the same behavior of his or her child (Lobstein et al, 2004). As a result, socioeconomic health inequalities carry through from one generation to the next. This is not only due to genes and individual behavior, but is also a result of conscious and unconscious social and political choices (Marmot, 2015). An example of this is the education system (e.g. in the Netherlands), where selection procedures are often less favorable for children of parents who are lower educated (Dronkers et al., 2016). A social safety net, equal opportunities in education and empowerment of the people at the bottom of the socioeconomic ladder are important political elements that can also help to reduce health inequalities (Marmot, 2015).

While much attention has been paid to the socioeconomic circumstances that may play a role in health inequalities, the role of lifestyle has only recently emerged. Several studies have shown that socioeconomic health differences are partly related to smoking, alcohol consumption, diet and/or physical activity. For instance, Wang and Geng (2019) show that lifestyle in general can be seen as a mediator between socioeconomic status and both physical and psychological health. Moreover, a meta-study by Petrovic et al. (2018) concluded that

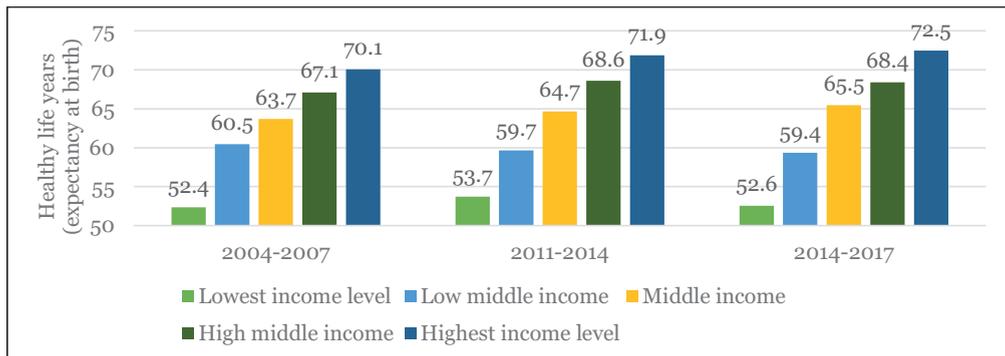
separate lifestyle factors contribute to the association between socioeconomic status and health outcomes, with smoking having the most impact. However, they also state that the contribution of lifestyles varies by geographic location, sex, age, health outcomes and methodological differences, including the way physical activities are defined. Until now, no study has examined the role of sport participation in explaining socioeconomic health inequalities. Apart from socioeconomic differences in health outcomes, other individual characteristics are also related to health inequalities. For instance, individuals that are overweight (having a body mass index (BMI) of 25 to 30) have a life expectancy of one year less than those on a health weight (BMI between 20 and 25). For severely obese individuals (BMI>35) the loss of life years in almost 10 years (Di Angelantonio et al., 2016). Overweight and obesity are in particular associated with higher risks of coronary heart disease, stroke, and cancer (Di Angelantonio et al., 2016).

**Figure 1.7 Healthy life years expectancy at birth in the Netherlands, by educational level (2007-2018)**



Source: CBS (2019b). Healthy life years expectancy is the number of years that an individual is expected to live in good health, which is defined as good perceived health.

**Figure 1.8 Healthy life years expectancy at birth in the Netherlands, by income level (2004-2017)**

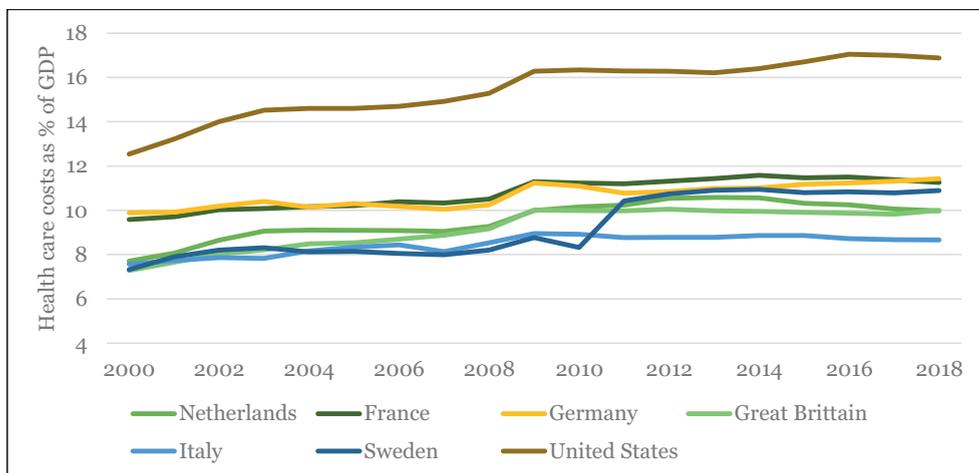


Source: CBS (2019c)

### 1.3 Health care costs

Improvements in health and well-being do not happen autonomously. Life expectancy and the number of healthy life years have increased due to, among other things, a much improved health care system. New medical knowledge and technology make it possible to have a longer and healthier life. As a result, the demand for health care has increased enormously. New medical interventions and medicines have arrived at considerable costs, partly because of the large investments necessary to develop them. Currently, many countries face health care costs that are increasing rapidly and at a pace that exceeds economic growth. Figure 1.9 shows that in the Netherlands, health care costs grew from less than 8% of GDP in 2000 to over 10% of GDP in 2018. For other countries similar patterns are visible, with the USA spending over 17% of GDP on health care. For many governments, containing the health care costs has become a major policy objective.

**Figure 1.9 Health care costs in selected countries, as % of GDP (2000-2018)**



Source: World Bank (2021)

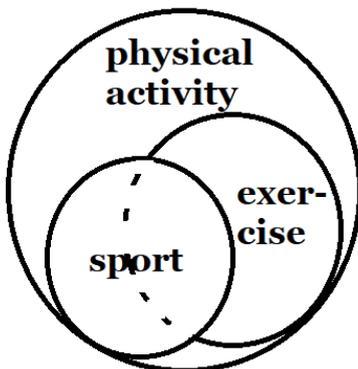
Unhealthy behavior is one of the reasons for high health care costs. According to the National Institute for Public Health and the Environment (RIVM), unhealthy behavior is responsible for about 20 percent of the disease burden and at least 9 billion euros in health care expenditure in the Netherlands (Hilderink & Verschuuren, 2018). Although themes such as health prevention and healthy lifestyle are becoming increasingly prominent in the political and public domain, their effects on health care costs are not clear-cut. Research on the relationship between healthy behaviors and health care costs shows that the burden of various diseases by improving lifestyle (quitting smoking, doing more physical activity, etc.) is often beneficial in the short term, but may actually lead to higher costs later in life (Polder

et al., 2012; RIVM, 2020). This trade-off occurs because a longer life often involves getting more and other (more expensive) medical treatments. However, the evidence on lifestyle effects on health care costs is relatively scarce and not without discussion. In addition, little is known about the socioeconomic differences in health care costs. This is therefore one of the research themes in this thesis. In addition, the role of lifestyle, especially sport and physical activity behavior, on socioeconomic inequalities in health care costs will be examined.

#### 1.4 Physical activity and sport

Physical activity can be described as “any bodily movement produced by skeletal muscles that results in energy expenditure” (Khan et al., 2012) and it consists of exercise, sport and other (unstructured) recreation. According to McFee (2004) sport is a specific subset of physical activity which includes an element of competition. In addition, sport consists of a set of rules and it can be undertaken individually or as a part of a team (McFee, 2004). By contrast, exercise consists of “planned, structured and repetitive bodily movement, the objective of which is to improve or maintain physical fitness” (Caspersen, Powel and Christensen, 1985). Most sports are within the limits of exercise, but some, such as mind sports, are not seen as part exercise but are still within the limits of the physical activity definition. Figure 1.10 shows a graphical representation of physical activity, sport and exercise in this framework. Other definitions on sport focus on a broad range of individual and societal benefits. For instance, the European Sports Charter defines sport as “all forms of physical activity which, through casual or organized participation, aim at expressing or improving physical fitness and mental well-being, forming social relationships or obtaining results in competition at all levels” (European Commission, 2007).

**Figure 1.10 Graphical representation of physical activity, sport and exercise**



Source: Khan et al. (2012)

In this thesis, we take a practical approach of using available data gathered through the validated Short Questionnaire to Assess Health-enhancing physical activity (SQUASH), which was established by RIVM, the Dutch National Institute of Public Health and the Environment (Wendel-Vos et al., 2003). In SQUASH, sport and physical activity are conceptually close to the definition of Khan, with the boundaries being demarcated by the type of activity, intensity and, in the case of sport, its purpose. In SQUASH, all activities during a week were recorded (self-reported), and a distinction was made between activities at work and school; commuting activities; household activities; and leisure time activities. All activities that generate an energy expenditure above a threshold of 3 metabolic equivalent of task (MET-value) of 2.0, using Ainsworth's compendium of physical activities (Ainsworth et al., 2011), are regarded as 'physical activity'. In addition, physical activities were into three intensity categories: light (2.0 to 4.0 MET), moderate (4.0 to <6.5 MET) and vigorous (6.5 MET or more). As a result, moderate to vigorous physical activity (MVPA) was defined as the physical activities with a MET-value of 4.0 or more. Sport activities were reported specifically in SQUASH as part of the leisure time activities (which also includes other hobbies such as gardening and do-it-yourself activities). Up to four sport activities could be reported in SQUASH, with all sports that had a MET-value of 4.0 or more included as sport in our analysis. This means that, in this thesis, walking and cycling are not part of sport, unless they were done as a leisure time sport discipline (e.g. mountain biking, race cycling, Nordic walking, etc.). As a result, walking and cycling for other purposes, such as commuting, are excluded from sport participation.

Research has shown that the choice of an individual on whether or not to exercise, and the frequency to do so, depends to a large extent on the personal characteristics of an individual, such as age, gender, ethnicity and leadership and economic factors such as income and employment status (Downward and Riordan, 2007; Humphreys and Ruseski, 2006). For sport participation, main determinants are gender, socioeconomic status, income, health, transport, as well as alcohol consumption, smoking, having children, marriage, hours of work and ethnicity (Downward and Rasciute, 2010). According to Poupaux and Breuer (2000), the economic factors (such as income) may be less important than the sociodemographic factors. From the supply side of sport, the range of sport facilities in the vicinity of the home of an individual has a positive and significant impact on the choice to work out and the frequency thereof (Poupaux & Breuer, 2000). Also, countries with higher sport participation have a higher consumption rate and a higher income per capita (Eber, 2003).

It is well established that physical activity is an important determinant of health. It has many positive health benefits, including a longer life expectancy and reduced chances of being diagnosed with cardiovascular diseases and diabetes (Aune et al., 2016; Meigs et al, 2006; He & Baker, 2004). Other positive health effects of physical activity include lower risks of obesity as

well as mental health illness such as dementia and depression (Reiner et al., 2013; Chekroud et al., 2018). There is also a considerable amount of knowledge about the economic effects of physical activity on health. For example, the direct costs of physical inactivity in the Netherlands are estimated at around one billion euros annually and the indirect costs, including absenteeism and productivity loss, some 3 billion euros (Breedveld, Kamphuis and Tiessen-Raaphorst, 2008). Several studies have found a relationship between the amount and intensity of physical activity and health indicators, such as the incidence of diseases or causes of death (see for example Coalter, 2007; Oja et al., 2015).

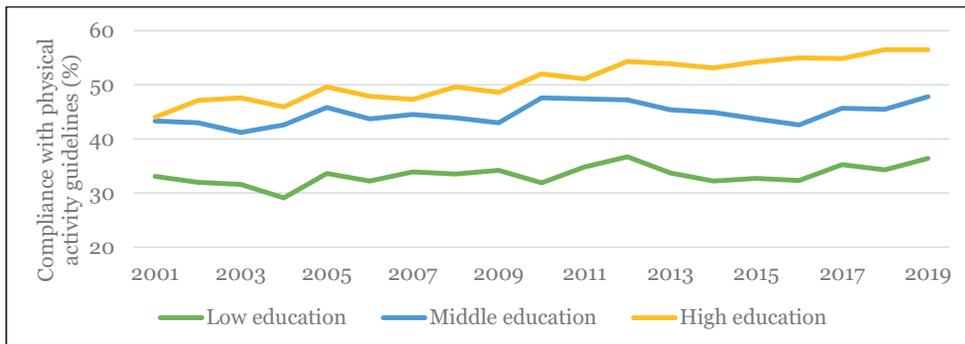
Although a great number of studies on the health effects of physical activity have been published, less empirical research has been done on the relationship between sport participation and physical health. Eime et al. (2013) state that there is more or less consensus that participation in sport for children and adolescents is more beneficial for both psychological and social health than leisure-time physical activity alone. This is remarkable, since sport is much more specific than physical activity and has particular characteristics. It stands out because it demands specific infrastructure (sport halls, swimming pools, etc.) and opponents, as well as coordination, for competition. To promote sport, specific policies and programs have been installed, often financed by public funds (Van Bottenburg, 1994). Often these investments have come from the idea that sport participation has specific social and health benefits (Steenbergen, 2004). There are several studies on the benefits of sport (see for example Coalter, 2007; and Boonstra and Hermens, 2011). In general, sport participation is associated with an increase in welfare (social impact), it promotes prosperity (economic impact) and also contributes to individual well-being (utility), which includes health. Although, some of the health-related findings are specifically drawn from research on sport, most of them have been established on exercise in general or physical activity (Coalter, 2007). There seems to be a causal relationship between sport participation and subjective well-being (Ruseski et al, 2014). Sport seems also to have a clear positive correlation with quality of life and a healthy lifestyle, according to Haskell (2007). This relationship is twofold: sport contributes to a healthy lifestyle (e.g. athletes participate more often in non-sporting leisure activities), but conversely, people with a healthy lifestyle also have a higher demand for, and more pleasure in, sport.

Apart from benefits, sport has also (social) costs. Direct costs are mostly related to sport injuries (Finch and Cassell, 2006). Indirect costs are for example the loss of productivity related to injuries or major sporting events and the opportunity costs of sport, such as when expensive land is sacrificed for a sport field or hall (Polinder et al., 2016; Preuss, 2009). In the already relative modest amount of research on sport participation in general, little attention is paid to the different aspects of sport participation, such as type or amount of sport practiced, or the social context of a sport.

## 1.5 Inequalities in physical activity and sport participation

There is a clear socioeconomic gradient in being physically active (Mackenbach et al., 2008; Beenackers et al., 2012). Figure 1.11 shows that, in the Netherlands, around 35% of the lower educated adults performed physical activity for 150 minutes or more on a weekly basis (the minimum amount according to the physical activity guidelines). For the last two decades, this number has been more or less stable. For the high educated group, this figure was over 55% in 2019, while it was less than 45% in 2001. Hence, the gap in physical activity between educational levels has increased considerably since the beginning of the century. This socioeconomic gradient in physical activity can in partly be explained by differences in the availability time and money, social capital and personal beliefs about physical activity (Van Sluijs et al., 2007; Wardle & Steptoe, 2003, Lindström et al., 2001). In addition, the availability of facilities for sport and physical activity and a supportive physical environment can also be important factors for physical activity behavior (Wicker et al., 2013; Giles-Corti & Donovan, 2002).

**Figure 1.11 Compliance with physical activity guidelines in the Netherlands, by educational level (2001-2019), persons aged 25 and over.**

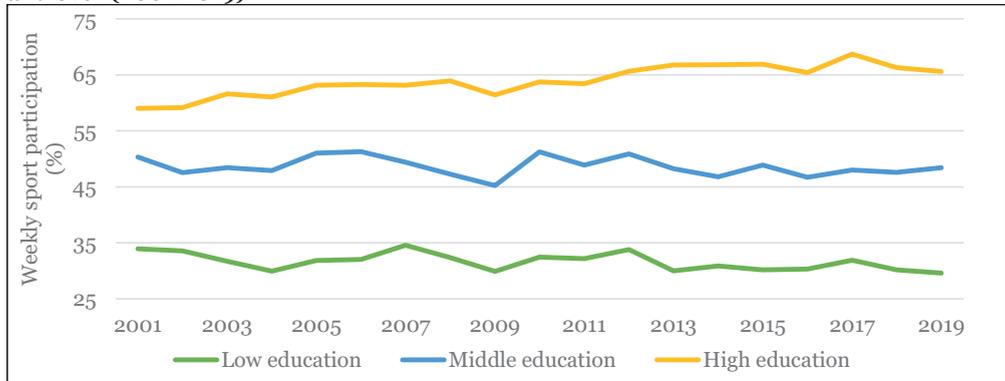


Source: CBS (2015), RIVM (2021)

Similar to physical activity, a strong socioeconomic gradient can be found for sport participation. Figure 1.12 shows that in 2019, over 65% of high educated individuals participated in sport on a weekly basis, while among low educated individuals this percentage was only 30%. Since 2011 the gap between low and high educated has also widened. The share of weekly sport participants among high educated increased by 7 percentage points (from 59% to 66%), while for the low educated group it decreased by 4 percentage points. However, in the first two decades of the 21<sup>st</sup> century an increase in both the average compliance with the physical activity guidelines and the weekly sport participation, was visible. This is mainly the result of a the strong increase of the share of high educated persons. Figure 1.13 shows

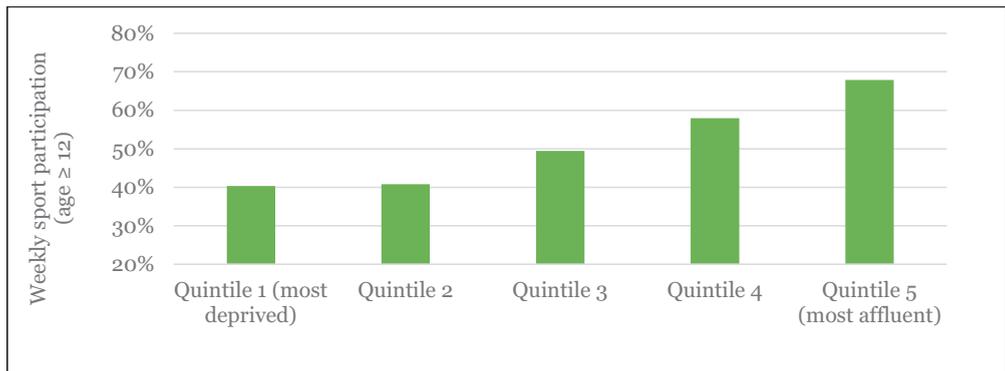
that there is also a very substantial gap in weekly sport participation between income levels. While sport participation in the Netherlands is just 40% in the lowest income quintile, this is almost 70% in the highest income quintile.

**Figure 1.12 Sport participation in the Netherlands, by educational level, persons aged 25 and over (2001-2019)**



Source: CBS (2015), RIVM (2021)

**Figure 1.13 Weekly sport participation in the Netherlands, by income level, 2019**



Source: RIVM (2020). Income levels defined by standardized disposable household income distribution in quintiles.

## 1.6 Objectives and research questions

Summarizing, socioeconomic differences translate to differences in sport participation and health outcomes. These inequalities are the focal point of the studies that are presented in this thesis. We investigate the role that physical activity and especially sport participation has on health outcomes, such as mortality and the incidence of type 2 diabetes mellitus. In addition, we look at the role of physical activity on socioeconomic differences in these health outcomes as well as health care costs.

The main aim of this thesis is to make a significant contribution to understanding to what extent sport participation, as well as physical activity in general, contributes to health and what role sport plays in socioeconomic inequalities in health and health care costs. Also, we will try to expand the knowledge on specific aspects of sport and physical activity in relation to health and health care costs and their inequalities. In this research, we will address the differences between being physically active in general and participating in sport in general. Our research should contribute to more evidence-based decisions with regard to public health, lifestyle and, in particular, sport. We hope our research will help improve sport, physical activity and health decisions by public policymakers, private companies and individuals.

The main research question of this thesis is: what is the relationship between sport participation and physical activity on the one hand and health and health care costs and their inequalities on the other? To answer this question, the first issue that we address is to establish the contribution of sport to health and to what extent differences in sport participation contribute to socioeconomic differences in health outcomes. This analysis includes delving into different aspects of sport participation, such as the amount, intensity and type of sports practiced. In addition, we stratify the outcomes for sport participation by socioeconomic levels, and compare the outcomes with those for physical activity in general. Next, we investigate whether there are differences in the association of participating in sport and physical activity with health outcomes with regard to inequalities in the individual's initial health status, by stratifying the population by body mass index levels. The second issue we examine is the relationship between sport and physical activity on the one hand and possible socioeconomic inequalities in health care costs. We do this by first investigating to what extent a neighborhood's health care costs is related to its socioeconomic status. This is followed up by an investigation of the role of sport and physical activity, as well as other lifestyle factors, in explaining the inequalities in health care costs between as well as within groups of neighborhoods with similar socioeconomic statuses. Finally, we investigate to what extent the Covid-19 pandemic has had an impact on socioeconomic differences in physical activity behavior.

In our research, we conceptually follow Grossman's model of health production (1972), where an individual is both seen as a producer and a consumer of health. Within this framework, physical activity (and participating in sport) features as an input for health. Additionally, lifestyle factors, including sport participation, can also be seen as a consumption good which enhances the individual's utility directly (e.g. doing sport itself is enjoyable) and indirectly (sport participation may increase life expectancy and thus the time available for doing enjoyable activities and consuming goods and services). Since improving health comes at a cost, it is also interesting, from a societal perspective, to get a better understanding of the role of these lifestyle behaviors on health care costs. In our research, we regard the individual's decision whether to participate in sport (or physical activity) and, for instance, the amount and type of sport as

exogenous variables, as we investigate whether they have an effect on several health outcomes. However, we realize that those decisions are not just independent, rational decisions. In reality, they can be influenced by many personal, social, mental, moral, psychological, environmental, as well as health factors. Although the causal relationship between sport and health runs both ways, our research mainly focus to the impact of sport and physical activity on health and health inequalities, while taking into account the initial health status (by including covariates), where possible. In Chapter 3, we delve deeper into the role of an individual's initial health status with regard to the relationship between physical activity and health.

All projects were carried out with data for the Netherlands, with three projects (chapters 2, 3 and 6) using individual level from the Lifelines cohort study, which comprises around 167,000 people from (mainly) the northern part of the Netherlands. For each research question a separate dataset was constructed which included only the individuals for which reliable and complete data was available for all relevant variables. This means that the sample sizes differ between the chapters and even within a chapter between datasets for different health outcomes. For the two projects on health costs (chapters 4 and 5), neighborhood level data that represent the full Dutch population were used, by combining data from Vektis (on health care costs), Statistics Netherlands (socioeconomic indicators) and other sources. For socioeconomic differences we use income levels and educational attainment (at the individual level) and socioeconomic status for neighborhoods in this thesis. Other measures, such as wealth or occupational position are also very interesting measures for socioeconomic inequalities, but not available for analysis in the datasets that we use.

## **1.7 Outline of the thesis**

In this theses, we present five separate research projects. First, we investigate the relationship between sport participation and health outcomes, with regard to socioeconomic inequalities (chapter 2) as well as with regard to differences in the initial (i.e. baseline) health status in the form of the Body Mass Index (chapter 3). Next, we examine to what extent there are socioeconomic differences in health care costs, at the neighborhood level (chapter 4), and whether the found differences are related to lifestyle factors (chapter 5). Finally, in chapter 6, we look at the Covid-19 crisis, that took a grip on societies all over the world in 2020, and explored to what extent the pandemic, and the related containment measures, had an effect on socioeconomic inequalities in physical activity in the Netherlands. In chapter 7, we summarize the main findings, draw the some conclusions and present suggestions for future public health policies.