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Inputs and Outcomes of Physical Activity: A Health Economic Perspective

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List of Abbreviations

DIW German Institute for Economic Research

DOSB German Olympic Sports Confederation

EU European Union

EBP Evidence-based policy

GDP Gross domestic product

GLM Generalized linear model

GSOEP German Socio-Economic Panel

HEPA Health-enchancing physical activity

HROI Health return on investment

ICD International Classification of Diseases

IE Incremental effects

LSLP Low-supply and low-performance

MET Metabolic equivalents

NCD Non-communicable diseases

NHS National Health Service

NPM New Public Management

OR Odds ratios

OOPC Out-of-pocket costs

PRISMA Preferred Reporting Items for Systematic Reviews and Meta-Analyses

PME Private market equilibrium

PPC Performance- and primary care-oriented

PPP Purchasing power parity

QALY Quality-adjusted life years

ROI Return on investment

RR Relative Risks

SHARE Survey of Health, Aging and Retirement

SC Supply- and choice-oriented

SD Standard deviation

SP Supply- and performance-oriented

SROI Social return on investment

UK United Kingdom

US United States

WHO World Health Organization

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1 Introduction

1.1 Relevance

Although many politicians and researcher, nowadays, do consider physical inactivity a global pandemic (Kohl et al., 2012) and the World Health Organization (WHO; 2018) has developed a global action plan in order to increase physical activity worldwide, public funding of this area in many countries remains precarious (e.g., Giannoulakis, Papdimitriou, Alexandris & Brgoch, 2017). Especially in times of austerity, public investments for promoting physical activity via, for example, infrastructure or behavioural interventions, are cut significantly (Parnell, Spracklen & Millward, 2017). From a health economic perspective, this is in particular problematic as the well-documented health benefits of physical activity (Humphreys, McLeod & Ruseski, 2014; Rasciute & Downward, 2010; Warburton, Nicol & Bredin, 2006) represent an effective mechanism to counteract alarming trends for health care systems worldwide. Increasing health care costs in many countries have put the fiscal sustainability of health care systems at risk (WHO, 2015) and against the backdrop of stark demographic changes (e.g., ageing population), the total health care costs are projected to increase from around 6% of the gross domestic product (GDP) to 9% in 2030 and as much as 14% by 2060. As a consequence, the WHO (2015) recommends countries to invest in public health promotion and disease prevention. These two goals may indeed both be accomplished by promoting physical activity.

Investments in public health promoting healthy behavior (e.g., physical activity), however, do not only have to square with tightening health budgets, they must also assert themselves against alternative health policy approaches focusing on expenditure on health care or health infrastructure. Such public health investments are moreover difficult to sell, given theirs effects tend to materialize rather in the long-term and their individual perception as being small belies their large impact on a societal level (Masters, Answar, Collins, Cookson & Capewell, 2017). In the interest of most rational decision making, detailed knowledge about the *value for money* of such public investments is needed (Banke-Thomas, Madaj, Charles & van den Broek, 2015). Performance measures initially developed for the private sector, therefore have come to be frequently used in public management to determine the relationship between inputs, outputs, and outcomes (Misch & Wolff, 2008). Thereby, economic evaluation techniques assessing the effectiveness and efficiency of public investments by economically quantifying these three factors have emerged as popular instruments as they allow comparing a wide range of public investments across

different public sectors (Schmid, 2005). Consequently, in the context of threatened funding, such measures could contribute to informed decision-making by public health officials and provide evidence to defend economically public investments directed at the promotion of physical activity.

However, the application of such analyses to physical activity promotion is challenging because of two main reasons. First, the relationship between economic inputs – i.e. public expenditure – and the output – i.e. participation in physical activity – is a highly complex one, since the respective impacts are not only rather long-term, but also hard to isolate from other macro-economic factors potentially affecting physical activity through externalities. Second, some of the adverse outcomes of participation in physical activity cannot be adequately expressed in monetary outcome measures which makes it difficult to use them in an economic evaluation analysis. Davies, Taylor, Ramchandani and Christy (2019) addressed those problems by conducting a social-return on investment (SROI) analysis when estimating the economic value of sport participation in the UK. A SROI analysis utilizes an evidence-base of inputs, outputs, and outcomes to estimate a SROI ratio. The study from Davies et al. (2019) considers outcomes in the area of crime, education, human resources, and physical and mental health and applied various valuation techniques to assign monetary values to those different outcomes. However, due to the various outcomes considered, SROI results should not be compared across different types of public investments (Maier, Schober, Simsa & Millner, 2015), rendering them impractical to justify public health investments in physical activity. Furthermore, Davies et al. (2019) stated that their SROI analysis lacks a more detailed measurement and valuation of health outcomes and, in particular, health economic modelling would be required to meaningfully estimate the different health-related relationships in the framework.

From a health economic perspective, a health return on investment framework (HROI) of physical activity is thus needed to address the shortcomings of the existing evaluation instruments, to assist governments in rationale decision-making on limited public health resources more generally, and to legitimize public efforts promoting physical activity.

1.2 Research questions and contribution

The present thesis aims to develop and contribute to a HROI framework for physical activity. As stated in the previous section, with health budgets under scrutiny over the last decade, a detailed understanding of how limited financial resources are spent most effectively and efficiently is of high relevance. Overall, the study provides a new framework to guide public health decisions on the basis of the existing evidence on the different relationships between public investments and

physical activity participation. Moreover, the thesis introduces new evidence to the input-output and output-outcome relationship in the framework by addressing the following two main research questions:

RQ1: How do public investments affect participation in physical activity?

RQ2: How is physical activity participation related to health costs?

The yet small body of literature on the effect of public investment on physical activity is extended by the provision of a detailed analysis for physical activity-oriented spending. It includes the consideration of different time frames and effect measures, as well as an empirical investigation of potential spillover and substitution effects from non-physical activity-oriented spending. Regarding the output-outcome relationship and the effect of physical activity on health care costs, on the micro-level, the thesis contributes to the literature by considering out-of-pocket costs as a monetary outcome measure and, on the macro-level, by specifically focusing on the health costs of physical inactivity in the context of aging societies.

1.3 Structure

Following the introduction, the theoretical framework is presented, which includes a section on physical activity and health and the theoretical background on public investments and economic evaluation. In the third part, the HROI model is introduced and the existing literature on the different parts of the model is presented and systematically reviewed. In chapters four to seven, the main part of the dissertation, the four different academic papers are presented. The chapters four and five take a look at the input-output relationship in Germany, with the first one investigating the relationship between public investments in sport and sport participation and the second one examining the relationship between other public investment areas and sport participation. Chapters six and seven focus on the output-outcome relationship. In chapter six the focus is on the relationship between physical activity and out-of-pocket health costs of the elderly in Europe. Chapter seven looks at the costs of inactivity in Germany and how they have developed over time and are projected to develop in the context of aging. In the last chapter, the results are summarized and an outlook for future research is provided.

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2 Theoretical background

2.1 Physical activity and health

The WHO (2019) defines physical activity as any bodily movement produced by skeletal muscles that requires energy expenditure. It includes physical activities while working, playing, carrying-out household chores, traveling, and engaging in recreational pursuit. The three participation characteristics of frequency, duration, and intensity are used to distinguish between the different activities. Thereby, *frequency* describes the number of times a physical activity is performed. It can be measured on a daily, weekly, or monthly basis. *Duration* reflects the length of time in which a physical activity is performed. In general, it is expressed in minutes or hours. The characteristic *intensity* measures the magnitude of effort required to perform a physical activity. The intensity of physical activities is usually categorized as either moderate or vigorous. Moderate describes an intensity of physical activity between 3.0-5.9 times of the intensity of rest on an absolute scale. It includes activities such as brisk walking, dancing, or gardening. Vigorous-intensity describes a participation intensity higher than 6.0 times of an intensity of rest. Examples are running, walking, or fast cycling. Research has shown that positive health outcomes are only achieved if physical activity meets a certain level of frequency, duration, and intensity (e.g., Warburton, Nicol & Bredin, 2006). As a consequence, the WHO (2010) has drafted global recommendations for those three participation dimensions. They vary for different age-groups. For the largest age-group of 18-64 years participation of at least 150 minutes once a week with moderate intensity or participation of 75 minutes of vigorous-intensity is required to yield potential health benefits. For the older age group (65 years and older), the guidelines are on a similar level, but declining physical abilities have to be taken into account. For younger individuals (5-17 years), daily physical activity of moderate-to vigorous-intensity of 60 minutes is recommended. Those recommendations are adapted with only small changes by many countries worldwide (National Health Service [NHS], 2011; Pfeifer & Rütten, 2017; Piercy, et al., 2018).

Given that physical activity considers all kinds of movement, two subcomponents are particularly relevant to meet those recommendations by the WHO. The first subcomponent is *exercise*. According to Caspersen et al. (1985) exercise distinguishes itself from general physical activity by the fact that it is planned, structured, and a repetitive bodily movement. The energy expenditure may vary between low and high, but the clear objective is to improve physical fitness. It refers to activities such as jogging, non-competitive swimming, or gym activities.

The second subcomponent is *sports*. According to the Council of Europe (2001, n.p.), sports can be defined 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." With the recommendations by the WHO in mind, not all sports are necessarily related to positive health outcomes. Participating in activities such as Darts or Pool does clearly not meet the recommended threshold of intensity. Hence, positive health effects are only assumed for sport activities with the objective of either directly improving physical and mental fitness or indirectly increasing the intensity through competition.

In the literature, physical activities associated with health benefits are described as health-enhancing physical activities (HEPA) (WHO, 2015). The scientific evidence of the health effects of HEPA is mostly conclusive. Epidemiological studies have created a considerable body of research and several authors have conducted systematic reviews or meta-analyses to evaluate the clinical evidence. Table 2.1 shows the most common health outcomes associated with physical activity by previous studies and presents review articles summarizing the respective epidemiological evidence. Of particular relevance are the positive outcomes for non-communicable diseases (NCDs; Cardiovascular diseases, diabetes type 2, cancer, and chronic respiratory diseases), the leading cause of death worldwide, with 63% of all death related to NCDs (WHO, 2018).

Table 2.1 Overview of systematic reviews on the most common health outcomes of physical activity

Health outcomes	Review Literature
Cardiovascular disease	
Ischaemic heart disease	Batty (2002); Wannamethee & Shaper (2001)
Stroke	Lee, Folsom & Blair (2003); Wendel-Vos et al., (2004)
Hypertension	Diaz & Shimbo (2013)
Type II diabetes	Jeon, Lokken, Hu & van Dam (2007); Aune et al., (2015)
Cancer	
Colon cancer	Quadrilatero & Hoffmann-Goetz (2003); Boyle et al., (2012)
Breast cancer	Friedenreich (2010); Monninkhof et al. (2007)
Rectal cancer	Spence, Heesch & Brown (2009); Slattery (2004)
Prostate cancer	Liu et al., (2011); Friedenreich & Thune (2001)
Chronic respiratory diseases	

continued on next page...

Table 2.1 Continued.

Health outcomes	Review Literature
Asthma	Eijkemans et al., (2012); Cindy et al.. (2012)
Osteoporosis	Moayyeri (2008); Gregg, Pereira & Caspersen (2000)
Depression	Teychenne, Ball & Salmo (2008); Dunn et al., (2001)

The field of health economics has more recently provided some additional insights. By conducting health economic research, previous findings from clinical studies were confirmed on a population-wide level. For example, Humphreys, McLeod & Ruseski (2014) found positive effects of regular physical activity on reported incidences of diabetes, high blood pressure, heart diseases, asthma and arthritis in Canada. In addition, health economic research has identified positive effects on subjective health and well-being (Lechner, 2009; Rasciute & Downward, 2010). Regarding the dose-response relationship between physical activity and health benefits, epidemiological and health economic research indicates that there are diminishing returns to participation in physical activity, meaning that the highest effects occur if someone moves from being inactive to active at some frequency, intensity, and duration (Bauman, 2004; Humphreys, McLeod & Ruseski, 2014). For the remainder of the thesis, the term physical activity refers only to physical activities with health-enhancing effects.

2.2 Public investments in physical activity

2.2.1 Economic rationale

From an economic perspective, the individual's decision to participate in physical activity is subject to the same market principles as any other consumer decision: Individuals try to maximize their utility under time and budget constraints and individual preferences determine the allocation of time and money to different activities. Previous research has developed various models to describe this demand for physical activity (e.g., Cawley, 2004; Humphreys & Ruseski, 2011).

In a free, competitive market, the demand should be at a Pareto efficient equilibrium with goods (e.g., access to infrastructure, equipment) needed to participate in physical activity which are supplied by the private market. A Pareto efficient allocation of resources means that nobody can be made better off without someone being made worse off which leads to a maximization of social welfare. If that is the case, governments do not have to intervene and instead only have to provide the institutional and legal framework for markets to operate (Stiglitz & Rosengard,

2015). However, if the market fails to operate efficiently and individuals' allocation of time and money happens not at a socially optimal level, government intervention may be necessary. In general, market failures can be broadly categorized into (1) externalities (2) objective information and (3) public goods (Cawley, 2004; Pratt, Macera, Sallis, O'Donnell & Frank, 2004; Sturm, 2004).

(1) Externalities denote the mismatch between private costs and benefits of engaging in certain activities and public costs and benefits that are unrecognized by free, competitive markets. Positive externalities thus occur when public benefits do outweigh private benefits, and negative externalities occur when public costs exceed private costs. Goods with positive externalities usually have lower private demand than what is publicly desired and are underprovided; and goods with negative externalities have a higher private demand than is publicly desired and are overprovided by the private market.

In the context of physical activity, one major positive externality is related to health care costs (Meyerhoefer, 2008). As discussed in the previous section, participation in physical activity creates numerous positive health outcomes which may translate into significantly lower health care costs. However, in many countries, the majority of health care costs associated with the individual's decision to participate in physical activity are beard by public health systems (e.g., health insurances) and not by the individual itself. Another positive externality related to the health benefits of physical activity can be observed in the labor market. A healthier workforce would result in higher productivity and, for example, fewer days absent at work. Such benefits for national economies are most likely external as well (Gratton, 1984). For both examples, the public benefits of higher physical activity participation would outweigh the private benefits, leading to an underprovision of goods necessary for the population to be physically active, on the one side, and to a lower demand for physical activity on the other. The goal of governments when investing money in the promotion of physical activity is to internalize the costs and benefits, so that consumers and producers make decisions based on the actual costs and benefits (Pratt et al., 2004).

(2) Information deficits occur if the private market underprovides objective information relevant to the individual's decision. In order to make rational, efficient decisions that maximize the utility, individuals have to be fully informed about the costs and benefits related to their decisions. Previous research indicates that individuals are often not aware of the numerous positive health effects of physical activity and as a consequence do not value the benefits of participation in physical activity properly which could lead to lower private demand than publicly desired (Brown, 2005; Kay, Carroll, Carlson & Fulton, 2014). Governments can either directly provide the missing objective information through investing in, for example, media campaigns or regulate information misguiding the individual's decision, for exam-

ple, advertisements promoting sedentary behavior. If information failures cannot be fixed, governments can subsidize physical activity participation to compensate the negative effects from imperfect information.

(3) Public goods are characterized first as non-rival, meaning that an individual's use of the good does not diminish the benefits someone else gets from its consumption and second as non-excludable, referring to the fact that the marginal costs of producing the public good to an additional individual are zero. As a consequence, competitive markets fail to efficiently provide levels of public goods as once the goods are produced, the private market cannot charge individuals due to the non-excludability. Hence, public goods are underprovided by the private market. For many physical activities, public goods such as open public spaces (e.g. parks, recreational areas) or safety are vital (Carver, Timperio & Crawford, 2008; Larson, Jennings & Cloutier, 2016) and as a consequence have to be financed by the government.

All three kinds of market failure lead to a private demand and a supply equilibrium that is lower than publicly desired. Participation in physical activity can thus be seen as a merit good (Sandy, Sloane & Rosentraub, 2004), since individuals are perceived as unable to properly evaluate the (health) benefits of physical activity participation, requiring governmental intervention to maximize social welfare by investing in the promotion of physical activity. Figure 2.1 illustrates the demand and supply curve of physical activity and the corresponding role of public investment.

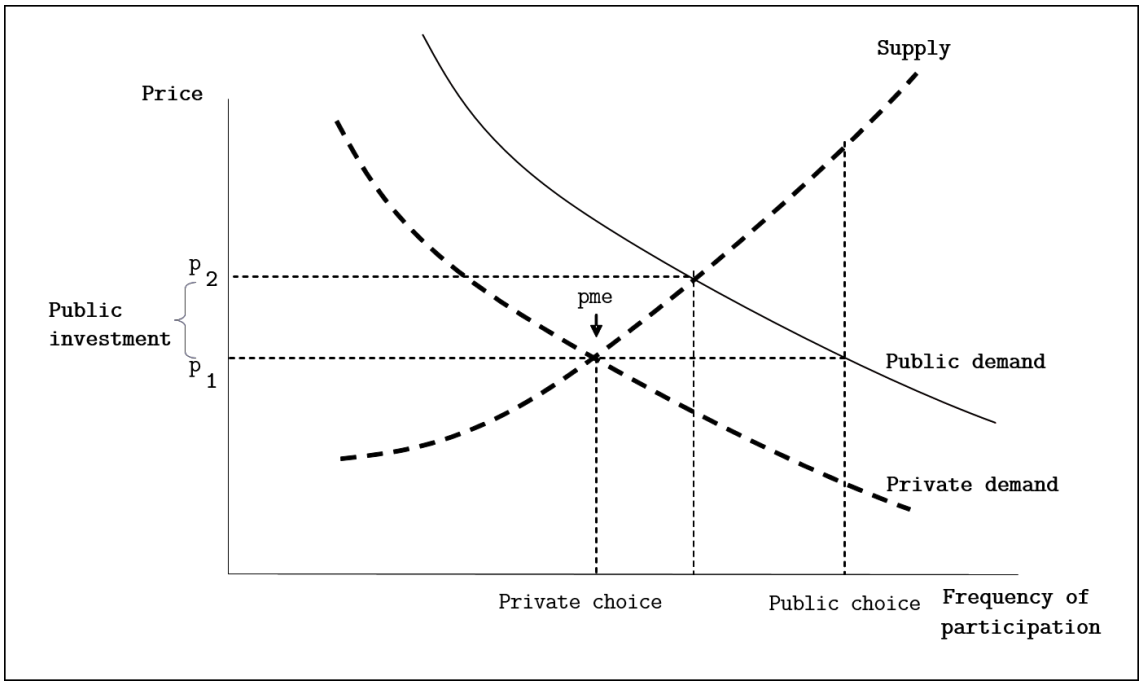

Figure 2.1 Demand and supply of physical activity and the need for public investments (adapted from Avice et al. 2011, p. 31)

The private market equilibrium (pme) for the demand for physical activity is lower than desired by the public. Increasing the public investment in physical activity reaches a new pme with demand closer to the public desired one. Thereby, the difference in price from p1 to p2 is covered by either subsidizing (public investments) the demand or supply side. For example, the government may subsidize memberships in sport clubs increasing the demand or they may fund infrastructure related to physical activity to support the supply side.

In addition to market efficiency, governments' decisions to invest in physical activity are often determined by equity concerns (Downward, Dawson & Dejonghe, 2009). Social disparities in physical activity participation are well-documented. Previous studies found that females, individuals with lower income, migration background, and those who live in rural areas being less likely to participate in physical activity (Downward, Lera-López & Rasciute, 2014; Giles-Corti & Donovan, 2002; Besharat Pour et al., 2014). Public investments can help to reduce those social inequalities of physical activity participation (Collins, 2004).

According to Le Grand (1982), there exist five strategies for governments to invest resources to achieve higher equity: equality of public expenditure, equality of final income, equality of use, equality of costs, and equality of outcome. A higher equality in each of those areas could be reached by public investments in physical activity. For example, the provision of direct funding to low-income families creates higher equality of public expenditure (Holt, Kingsley, Tink & Scherer, 2011). Taxation could be used to reduce income differentials which, in turn, would result in higher equality of income (Spence, Holt, Dutove, & Carson, 2010) and subsidizing the participation in physical activity would improve the access to the needed goods and services and thus, would create higher equality of use, costs and outcomes.

In general, governments often face an equity-efficiency trade-off when allocating financial resources, given that maximizing market efficiency usually leads to lower levels of social equity (Gratton, 1984). In the field of public health, the topic has been extensively discussed for decades (Wagstaff, 1991). It is argued that the goal of health maximization of a population does not sufficiently take into account distributional matters. However, Reidpath, Olafsdottir, Pokhrelm, and Allotey (2014) found the idea of an equity-efficiency trade-off to be misleading in the context of public health, since efficiency is describing the relationship between sought outputs and the level of inputs, whereas equity can be an integral part only of assessing the output. As a consequence, the authors suggested the discussion to revolve more around the trade-off necessary between the range of different outputs that governments consider when allocating public health resources. In this context, economic evaluation could provide "policymakers a clearer, more balanced, and more evidence-informed understanding about the nature, size, and importance of any policy trade-off" (WHO, 2015, p. 271).

2.2.2 Economic evaluation

The previous section has outlined how public investments in physical activity are being made under the premise of creating benefits – primarily related to health – for the population. With their financial resources mostly generated through taxes, governments however operate under budgetary constraints that co-determine the modalities in which to achieve those benefits of physical activity. Therefore, trade-offs are necessary between different investments in physical activity and between investments in physical activity and other investment areas (e.g., health, education). Economic evaluations of public investments lend themselves as guidance for public officials' decision-making. Over the last decade, the economic crisis in 2009, demographic trends, and the globalization all have increased the pressure on public budgets significantly (Mandl, Dierx & Ilzkovitz, 2008). Against this backdrop, economic evaluations of public investments have become more and more popular. Starting in the 1980s, governments worldwide came under pressure and spurring various reforms, known as the *New Public Management* (NPM), while borrowing management tools from the private sector to assess the subsequent performance of public sectors (Van Dooren et al., 2010). With the beginning of the 2000s, the *Evidence-based policy* (EBP) movement of public performance measurement emerged. EBP emphasizes the use of outcome measures to inform policymaking decisions.

The measurement of performance follows a production logic, describing the relationship between input, output, and outcomes.

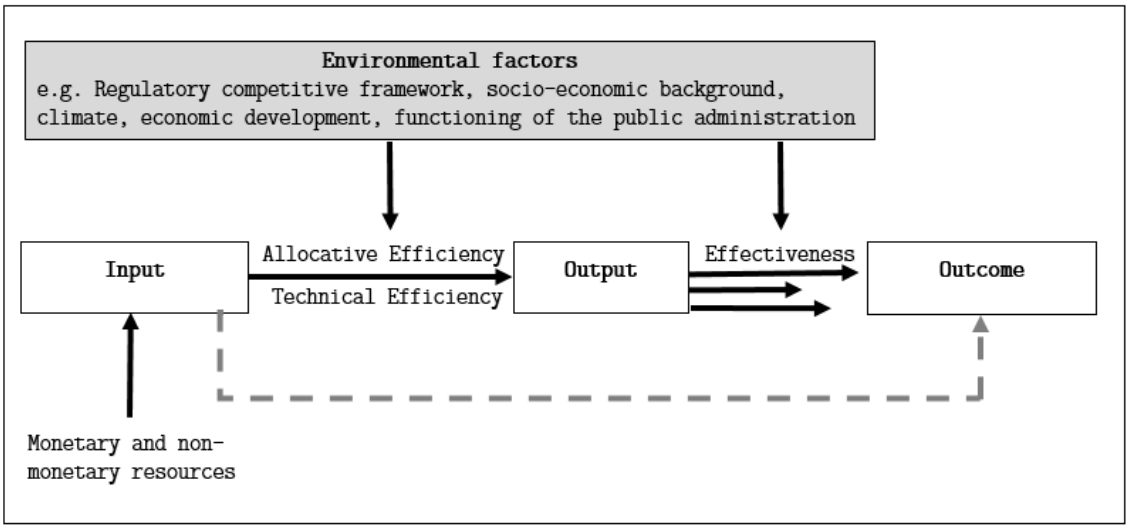

Figure 2.2 Conceptual framework of efficiency and effectiveness of public investment (Mandl, Dierx & Ilzkovitz, 2008)

Figure 2.2 visualizes this relationship. In general, the input provided by the government can either be monetary or non-monetary. With the focus on public investments, input is primarily considered as monetary. Insofar, the input generates output directly. For example, in the context of health, public investments in hospi-

tals (input) result in more patients treated in hospitals (output). Output, in turn, produces an outcome. Outcomes are defined as the effects of the input. With a view to the previous example, because of public investments in hospitals and the output of more patients treated, the overall health in the population increases (outcome). The relationship between the three measures input, output, and outcome are affected by environmental external factors and can be assessed by using the concepts of efficiency and effectiveness.

Efficiency describes the ratio of inputs to outputs, whereas effectiveness refers to the absolute success of meeting a public investment objective and concerns the relationship between outputs and outcomes (Mandl, Dierx & Ilzkovitz, 2008). Economic evaluation techniques serve to measure both of these relations. The three most common economic evaluation techniques are cost-effectiveness analysis, cost-utility analysis, and cost-benefit analysis. Cost-effectiveness analyses measure the costs in monetary units and the outcome in natural units, for example, improvements in health. An adaption of the cost-effectiveness analysis is the cost-utility analysis were a utility-based measure is used to describe the outcome. In the public health context, quality-adjusted life years (QALYs) represent such a measure as it includes information on quantitative and qualitative aspects of health (Whitehead & Ali, 2010). The cost-benefit analysis measures the input and the output in monetary terms. It takes into account that market failure means market prices are not available for all costs and benefits. Instead, those intangible benefits can be monetarized by applying revealed and stated preferences approaches such as the travel cost method, hedonic pricing, or the contingent valuation method (Orlowski & Wicker, 2019). Previous studies have applied cost-benefit analysis to public spending on education (e.g., Levin, Belfield, Muennig & Rouse, 2007), transport infrastructure (e.g. Eliasson, Börjesson, Odeck & Welde, 2015), the environment (e.g., Hanley, 2001), and health (Robertson, Skelly & Phillips, 2019).

The concept of a SROI analysis has become a popular economic evaluation instrument to guide and justify policymakers' decisions with primarily social purposes (Arvidson, Lyon, McKay & Moro, 2013). Similar to a cost-benefit analysis, a SROI analysis focusses not only on direct monetary effects but instead, considers general societal impacts and aims to put a monetary value to it. It can be understood as an adjusted cost-benefit analysis taking into account the different types of impact, public services, programs, or spending (Lawlor, Neitzert & Nicholls, 2008). Thereby it follows the same production logic as outlined in figure 2.2 where the inputs are compared to monetary outcomes, leading to the estimation of the SROI ratio (Arvidson et al., 2013). The estimation is based on five different steps. The analysis starts with defining all the stakeholders affected by the impact of the public initiative. In a second step, respective inputs, outputs, and outcomes have to be identified. Thirdly, in addition to monetary outcomes, financial proxies are assigned to the

non-monetary outcomes. Fourth, the impact is established meaning that aspects such as duration, weighting, and displacement are considered. In the last step, the SROI ratio is calculated. Therefore, the total value of the outcomes is divided by the total value of input which provides a measure for every €1 invested. Maier et al. (2015) found that the two major merits of SROI analyzes are that they provide legitimacy to non-profit organizations and their funder and that they can help to allocate financial resources efficiently and effectively.

The SROI framework can be applied to various interventions and public policies. For example, in the past, it was utilized to estimate the value returned of investments into transport infrastructure (Wright et al., 2009), built environment (Watson et al., 2017), and non-profit and social enterprises (Cordes, 2017). For health-related matters, research focused primarily on health promotion, mental health, child health, and health care management (Banke-Thomas, Madaj, Charles & van den Broek, 2015). With regard to physical activity, King et al. (2014, p.160) stated that SROI could well be a useful tool for public authorities in terms of:

"strategic planning and influencing decisions around procurement, in the development of a "business case" such as targeted investment, value-for-money and service efficiencies and effectiveness, in building accountability and transparency; in demonstrating outcomes and hidden savings for partner organisations; building stakeholder engagement; for attracting investment, developing the "political case" in raising the profile of services; and in making a "social case" to justify welfare oriented interventions."

Consequently, previous research used SROI analyses on the evaluation of sport infrastructure (KPMG, 2018) and single interventions (Sanders & Raptis, 2017). Evidence regarding a nation-wide context, however, remains rather small. Recently, Davies et al. (2019) published a study on the value of sport participation in England including the application of the SROI measure. Figure 2.3 shows the applied SROI framework.

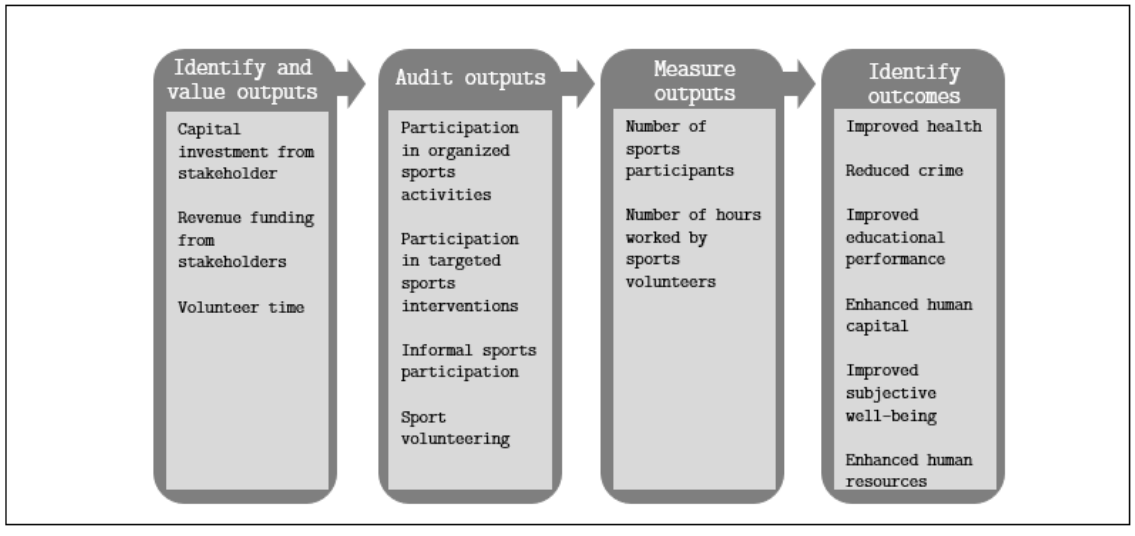

Figure 2.3 Impact map of a SROI analysis (Davies et al., 2019)

In general, the framework is built on an evidence-base which covers the existing literature dealing with the different relationships. The authors did thereby not restrict the evidence to the UK but instead used international-wide research. Also, they did not differentiate between physical activity and sport participation as long as the activity meets the minimum threshold of the guidelines of the WHO (2010).

On the input side, primarily monetary investments by governments were considered either directly, in terms of revenue, or indirectly, in terms of capital investment. Moreover, a monetary value for the total value of volunteering time was included. The outputs take into account various measures on the increased participation in the sport sector. For example, the number of sport participants and the number of hours worked by sport volunteers. Overall, six different outcome measures were included: improved health, subjective well-being, educational performance, enhanced human capital and human resources, and reduced crime. After reviewing the existing literature and applying the findings to the UK, a SROI ratio of 1.91 meaning for every £1 invested £1.91 worth of social impact was generated.

The study indicates that the SROI framework can be applied to value the wider benefits of sport participation to society by considering multiple outcomes. However, one of the main limitations of the method is the comparability across different public investments (Maier et al., 2015). Hence, it is difficult to make an argument for investing in sports in comparison to other public spending areas. Consequently, taking a health economic perspective can be beneficial for mainly two reasons. First, with the positive health effects as the main rationale for public investments in physical activity in mind, the estimated values can help governments to compare the results to other public health investments (e.g., prevention of smoking, drinking, unhealthy eating) and second, Davies et al. (2019) have outlined that their analysis lacks detailed measurements and valuation of health outcomes and that health economic modelling is indeed required to estimate not only the input-outcome relationship, but also the input-output and output-outcome relationship. In a similar vein, Banke-Thomas et al. (2015, p. 11) stated that "there is clearly a need for SROI practitioners and public health researchers to collaborate in developing a more widely acceptable and perhaps more robust quality assessment framework for public health SROI studies [...]." An HROI framework would address this call and provide a structure of the existing empirical evidence on the different relationships in the context of public health and, then, in a second step, could enable public officials to estimate an actual HROI value.

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3 Health return on investment of physical activity

3.1 Health return on investment framework

An HROI framework of physical activity adjusts the SROI model by only considering health-related outcomes. Figure 3.1 outlines the HROI of physical activity framework.

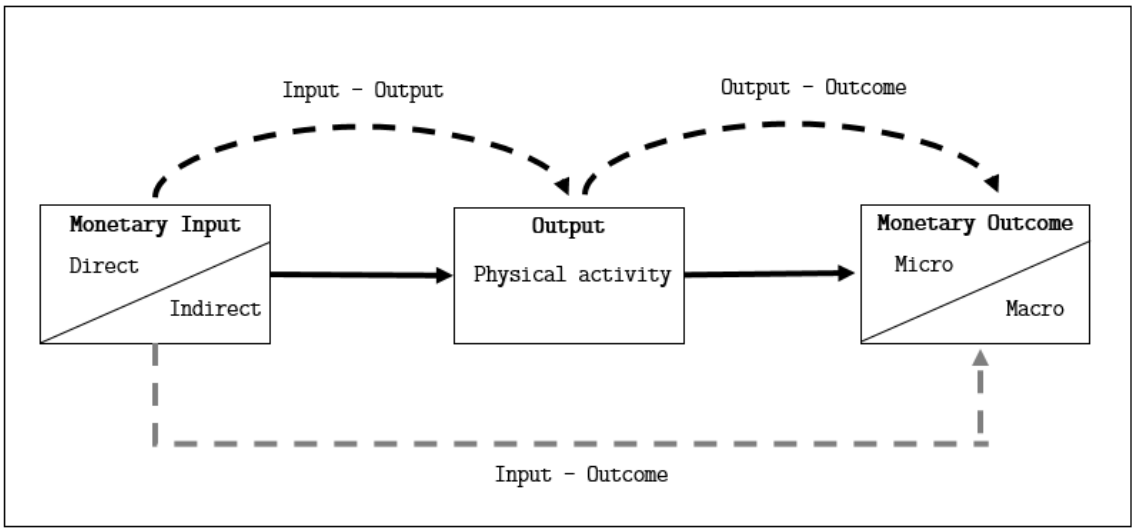

Figure 3.1 HROI of physical activity framework

The input side considers public investments promoting health-enhancing forms of physical activity (e.g., sport participation, exercise). It differentiates thereby between direct investments specifically directed at the promotion of physical activity (e.g., funding of sport clubs, sport facilities) and indirect investments (e.g., education, health) which have not the main objective of increasing physical activity but can still have potential external effects (spillovers). The input creates outputs in terms of different forms of physical activity (e.g., exercise, sport participation) representing the input-output relationship. The output of increased physical activity participation generates various health outcomes. It describes the output-outcome relationship. From a cost-benefit perspective, those health outcomes have to be transformed into monetary values. It can be distinguished between effects on the micro- and macro-level. The micro-level looks at the effects on the individual whereas the macro-level refers to impact on the entire health care system.

It should be noted that estimating an actual HROI value by applying the different steps of a SROI analysis is beyond the scope of this thesis. Instead, the concept serves as a framework for the four academic papers presented in chapters four to

seven. In the following, first, the method of the systematic review of the existing literature on the different relationships in the framework is presented. Afterwards, the following sections summarize the empirical evidence for every relationship. In addition, the subsections then outline the contribution of the academic papers to the underlying evidence-base and how they fit into the HROI framework.

3.2 Method of systematic literature review

The systematic review was conducted based on the standards of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. PRISMA was developed by 29 review authors, methodologists, clinicians, medical editors, and consumers in 2005. It aims to assist authors with the transparent and complete reporting of systematic reviews and meta-analyses. Therefore, a 27-item checklist and a flow chart (Figure 5) setting guidelines for the review has been created.

Regarding the literature search, the four databases *Scopus*, *PubMed*, *EconLit*, and *SportDiscus* were utilized and the search was conducted by using combinations of the following search terms: “government spending”, “public investment”, “public expenditure”, “physical activity”, “sport participation”, “health costs”, “health spending”, “health savings”, “medical expenditure”, “medical costs”, “cost effectiveness”, “return on investment”, “cost-benefit”. Only articles published in peer-reviewed journals until August 2019 were included. The results of the electronic search process are shown in figure 5 which represents a flow chart based on the PRISMA statement but applied to the HROI framework.

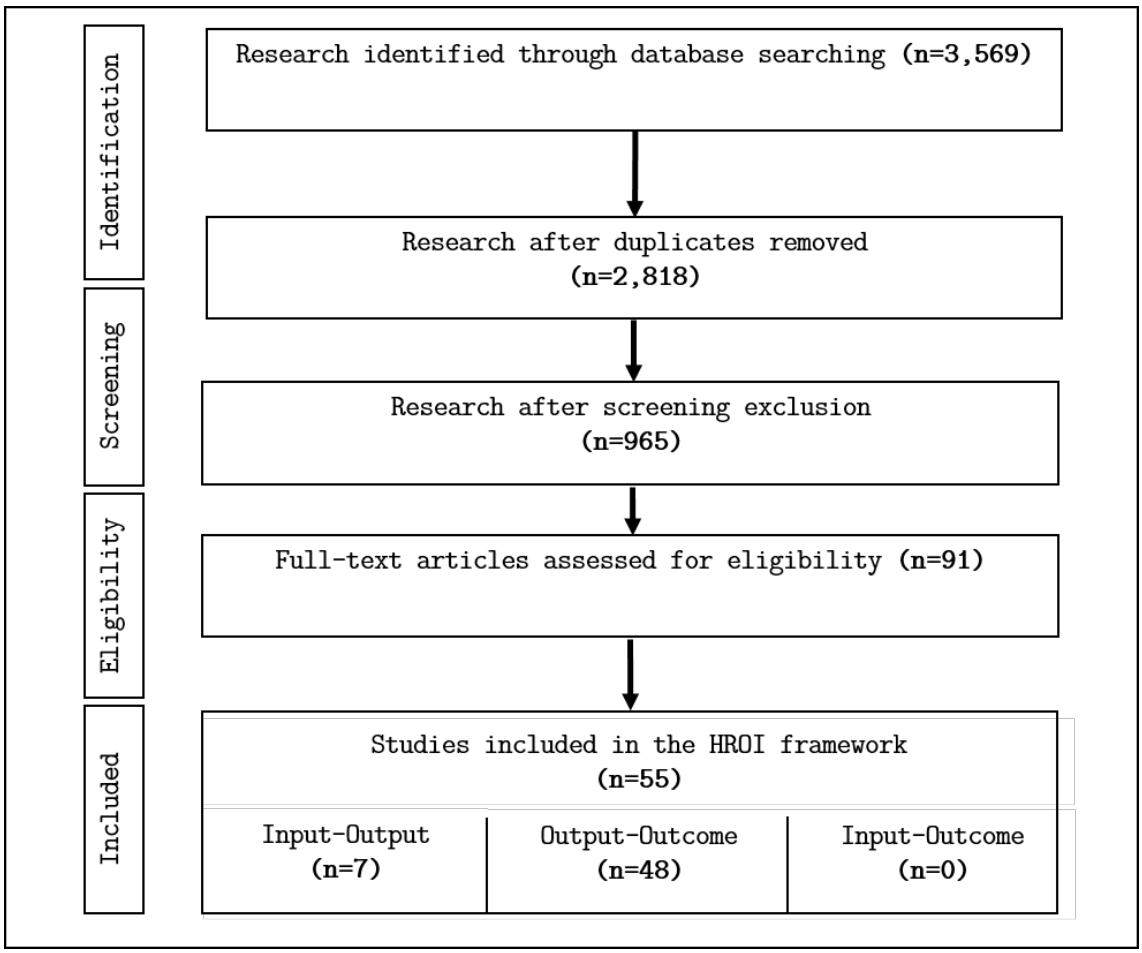

Figure 3.2 Flow chart of the systematic literature review

The initial database search provided a total of n=3,569 citations. After removing duplicates, n=2,818 publications remained. Then, the studies were screened based on the inclusion criteria of using a quantitative research design and providing a direct estimation of the input-outcome, output-outcome or input-outcome relationship. The remaining n=91 studies were then checked if they provide input, output, and outcome measures relevant to the HROI framework. The final results show that n=55 publications qualified including n=7 for the input-output relationship and n=48 for the output-outcome relationship. No publications could be identified for the input-outcome relationship.

3.3 Input - Output

3.3.1 Direct

The input-output relationship between monetary inputs and physical activity participation has been primarily assessed for single interventions. A large body of research exists dealing with the effects of mass media campaigns (e.g., Bauman & Chau, 2009; Marcus, Owen, Forsyth, Cavill & Fridinger, 1998), interventions targeting individ-

ual health behaviour in general (e.g., Heath et al., 2012) or at the workplace (e.g., Dugdill, Brettle, Hulme, McCluskey, & Long, 2008) and community, environmental or policy interventions to promote physical activity (Sallis, Bauman & Pratt, 1998). Only a few studies have looked at the relationship between public investments directly addressed at physical activity and physical activity participation on a population-wide level. Therefore, usually, a regression framework with the dependent variable measuring physical activity and an independent variable measuring public investments directly related to the promotion of physical activity is applied. To estimate the model, researcher have to combine data on the individual level with information on public investments form a higher level (e.g., country, state, regional).

Downward, Lera-López and Rasciute (2014) included government expenditure on sports on a country-level in their analysis of the correlates of sport participation in Europe. By using the Eurobarometer 72.3 data, the authors combined individual data from 2009 with country-level information. The public investment variable referred to the annual sport expenditure of the EU-member states per capita without specifying the specific purpose of the spending. The results showed a positive relationship between the sport-related public spending and any sport participation and participation frequency.

On a lower level, Kokolakakis, Lera-López and Castellanos (2014) looked at regional differences in sport participation in England in 2010/2011. They created averages of individual data for every local region and combined it with regional variables. Sport participation was measured as the percentage of people in the region who have participated in sports. A comprised measure and a three-year average of the lottery funding used to promote sport, exchequer awards, and capital expenditure on sport were included to describe sport-related public spending. The results revealed no significant relationship, and the authors provided substitution effects from the private sector as a potential explanation. However, in a similar study Kokolakakis, Castellanos and Lera-López (2017) used the same dataset and looked at regional differences between formal and informal sports participation. The results revealed for the same comprised measure of lottery funding a significant positive effect when comparing formal sport participation to no sport participation.

Hoekman et al. (2017) also utilized regional data of local government sport expenditure in the Netherlands. To deal with the different levels of data, a multi-level analysis was conducted. The expenditure data directly related to sport mainly referred to spending on voluntary sport clubs and public sport infrastructure. It reflected the net expenditure per capita by the municipalities and a four-year average was calculated. The findings showed that the effects were most substantial for sport club participation by the youth. For adults, the effects were significantly negative which according to the authors could be attributed to a potential reverse causality problem.

3.3.2 Indirect

Similar to the previous section, the relationship between public investments indirectly related to physical activity and physical activity participation is estimated within a regression framework. Again, researcher have to decide how to deal with different levels in their analysis when combining macro-level public investment information with individual physical activity participation data.

Humphreys and Ruseski (2007) were the first looking at this when studying the effect of public spending on parks and recreation spaces on physical activity in the United States. The public investment was measured as annual total noncapital spending on parks and recreation. To account for the multi-level structure, the standard errors on the state-level were clustered. The study revealed that public investments had a significant positive effect on participation in group sports but a negative effect on participation and time spent on walking for exercise.

Van Tuyckom (2011) focused on public spending on health and the relation to physical activity participation for EU-member states. Individual physical activity data was aggregated, and analyses on the country level were conducted. The spending variables were measured as the annual percentage of total government expenditure on health. The results showed a positive effect on participation in physical activity.

Lera-López, Wicker and Downward (2016) built on that work and added spending on education. Section five explains in greater detail the mechanisms through which public spending on health and education are potentially affecting participation in physical activity. In their multi-level analysis, the authors used five-year averages and measured the spending on health and education as the percentage of the national GDP of the EU-member states. The results showed primarily a positive effect for education spending on participation in sports and physical activity. Health expenditure was mainly associated with sport participation of medium frequency. Wicker and Downward (2017) utilized similar data from the Eurobarometer 80.2 of the year 2013. They included measures of government quality and their estimated multi-level models indicated mostly no significant effect of health and education expenditure on numerous sport participation variables.

Kino, Bernabé and Sabbah (2017) were not able to replicate the results from Lera-López, Wicker and Downward (2016) when studying the effect of healthcare and education system on the co-occurrence of health risk behavior in the EU. They argued that the significant effects disappear once you include the total GDP as a control variable. However, they further stated that the different measures of physical activity might be another factor causing those differences.

3.3.3 Summary and contribution of chapters four and five

Overall, the evidence for the effect of direct public investments to support physical activity on physical activity participation proves to be limited. Previous studies have looked exclusively at sport-related spending, identifying either positive, negative, or non-significant effects. The different types of investment (funding of sport clubs, general promotion of sport), country-specific aspects (England, Greece, the Netherlands), varying time periods (annual or three year averages), and different empirical strategies to deal with the multi-level structure (multi-level modelling, clustered standard errors) may serve as potential explanations for these inconclusive findings.

Chapter four will present a study addressing some of those exact shortcomings. The study applies a multi-level framework to the relationship between three different sport-related spending categories (e.g., investments in sport facilities, swimming pools, and general promotion of sport) and sport participation. In addition, the study takes into account that the effects, especially for investments in sport infrastructure, are most likely lagged and utilizes averages of three different periods (5, 10, and 15 years). The results indicate that only spending on swimming pools for the periods of 10 and 15 years are related to individual sport participation. Moreover, the study shows that inconsistent investments – most likely representing larger investment projects – are favorable for investments in swimming pools whereas consistent spending covering maintenance costs are preferable for investments in sport facilities.

For indirect public investments in physical activity, the existing research is likewise limited. However, the findings do indicate positive effects of spending on public spaces (parks, recreational areas), as well as do investments in health and education. The public investments are made either on a state level or a country level and, again, the empirical strategy to deal with the multi-level structure differs.

Chapter five adds to those findings by expanding the public investment categories of indirectly affecting physical activity with spending on transport infrastructure (public transport, streets) and the environment and considering potential negative substitution effects for cultural public investments. The study also includes direct effects of sport-related spending. It takes into account the different measures of the public investments by comparing the results between annual and three-year averages of spending per capita and relative investments of total public spending. The findings indicate positive spillover effects for spending on transport infrastructure, but observe no substitution effects. The results prove robust across the different measures of public investments.

3.4 Output - Outcome

3.4.1 Micro

On the micro-level, the relationship between physical activity and the monetary outcome can be assessed either directly by looking at the effect on health costs or indirectly by applying monetary valuation techniques. The direct method employs an econometric approach utilizing data which links the physical activity participation to individual health costs. The physical activity information either stemmed from self-reports in surveys (e.g., Aljadhey, 2012; Andreyeva & Sturm, 2006; Carlson, Fulton, Pratt, Yang & Adams, 2015; Min & Min, 2016) where the provided information differed in terms of frequency, intensity, and duration, or objectively via accelerometer or pedometer (e.g., Bueno et al., 2017; Towne et al., 2018; Yoshizawa et al., 2016). The information on health costs was either reported by the individuals (e.g., Carlson et al., 2014; Chevan & Roberts, 2014) or administrative health care claim data was used (Anderson et al., 2005; Bland, An, Foldes, Garrett & Alesci, 2009; Goetzel et al., 2012; Min & Min, 2016). Most studies used a comprised measure of total health costs including inpatient, outpatient, and prescription expenditures. Chevan and Roberts (2014) and Peeters et al. (2014) were using differentiated cost measures in their analysis including out-of-pocket costs.

It can be distinguished between studies that have looked at secondary data of a national-wide population and research explicitly looking at physical activity interventions with primary data. For example, Carlson et al. (2015) and Andreyeva and Sturm (2006) were using national wide survey data whereas Alva et al. (2017), Codogno et al. (2011), Navratil-Strawn, Hartley and Ozminkowski (2016), Towne et al. (2018), and Yoshizawa, Kim and Kuno (2016) focused on intervention in the community or at the workplace to increase physical activity.

Based on the underlying data, the sample size differed considerably between the studies. A few analyses only investigated a subpopulation where the focus was either on health conditions such as cardiovascular diseases (Okunrintemi et al., 2019; Valero-Elizondo et al., 2016; Wang et al., 2019), hypertension (Aljadhey, 2012; Bueno et al., 2017), diabetes (Alva et al., 2017; Bueno et al., 2018; Codogno et al., 2015), mental disorders (Brown, Wang & Safran, 2005), or on specific sociodemographic groups such as the elderly (Aoyagi & Shephard, 2011; Towne et al., 2018; Yang et al., 2016) or women (Brown, Hockey & Dobson, 2008). Independent from the health status of the individuals, most of the literature identified a negative relationship between health costs and physical activity. A comparison between the studies is difficult due to the different contexts, but the potential savings were of considerable sizes in most analyses. For the studies employing secondary data with no specific sample selection, a reduction between 11.7% (Min & Min, 2016)

and 29.9% (Carlson et al., 2015), if someone is active compared to non-active, was observed. The estimates for physical activity interventions tended to be higher. Yoshizawa et al. (2016) found a reduction of 44.6% for Japanese adults and Towne et al. (2018) found considerable savings above 30% on average. Studies investigating different physical activity levels identified diminishing returns meaning that usually the highest marginal savings can be generated by moving from inactive to active (Brown et al., 2008; Carlson et al., 2015; Yang et al., 2011).

The second method estimates the monetary value indirectly by focusing on the contribution of physical activity to mental well-being and then assigning a monetary value to the effect by applying the compensation variation technique (Orlowski & Wicker, 2019). Downward and Rasciute (2011) studied sport participation in England and found that on average, individuals valued sport participation between £19,000 and £23,000 a year. Every extra minute of sport participation was valued at £215. However, it was unclear if the individuals valued the health benefits improving their well-being or other drivers positively influenced by being physically active. Hence, Downward and Dawson (2016) tried to break this effect further down. By applying an instrumental variable approach, the authors found that well-being above the threshold of guidelines for health benefits has a higher monetary value than sport participation meeting those criteria indicating that the individuals do not only value health benefits. Orlowski and Wicker (2018) took the heterogeneity of the well-being measure into account by estimating a generalized ordered probit model. They focused on Germany and found that the monetary value increases with participation frequency. For participation once a week, individuals were willing to forgo between €577 and €1662 monthly.

3.4.2 Macro

The macro perspective considers the health costs for the economy or the health care system rather than for the individual. To identify the direct total health costs for a population, the most common approach is the comparative risk assessment methodology. The approach can be divided into five steps:

1. Identifying diseases associated with physical inactivity and the relative risks
2. Determining the prevalence of the risk factor physical inactivity
3. Determining the health costs associated with the previously identified diseases
4. Calculating the population-attributable fraction (PAFs) for each disease
5. Applying the PAFs to the health costs of the diseases

In the following, the application of the five steps by previous research is reviewed and the results are compared. For the first step, many studies based the diseases

included in the analysis on a report by the WHO (2004) which provided a review of diseases frequently associated with physical inactivity (Allender, Foster, Scarborough & Rayner, 2007; Maresova, 2014; Oldridge, 2008; Scaraborough et al., 2011; Zhang & Chaaban, 2013). As outlined in section two, the most relevant diseases are ischemic heart disease, ischemic stroke, diabetes type 2, female breast cancer, colon cancer, and hypertension. Some studies extended the list and included osteoporosis (Colditz, 1999; Katzmarzyk, Gledhill & Shephard, 2000; Janssen, 2012; Krueger et al., 2016) or mental diseases such as depression or anxiety disorders (Chenoweth & Leutzinger, 2006; Mattli et al., 2019; Martin et al., 2001).

In the second step, the prevalence of physical inactivity is usually determined with information on the physical activity behavior of the population of interest. Most studies used survey information with heterogeneous definitions of physical inactivity. The definition differed in terms of intensity, time frame, and frequency (Ding et al., 2017; Pratt, Norris, Lobelo, Roux & Wang, 2014). A few studies used the recommendations by the WHO (2010) as an orientation (Maresova, 2014; Mattli et al., 2019) or utilized energy expenditure measures (Katzmarzyk & Janssen, 2004; Krueger et al., 2016). Janssen (2012) based the physical inactivity measure on actual data stemming from actical accelerometers.

Third, the outcome measure of health costs is defined. In general, it can be differentiated between direct and indirect costs. Direct costs describe the costs of goods and services for diagnosis treatment and rehabilitation of the different diseases (e.g., hospital care expenditures, drug expenditures, physician care expenditures, expenditures for care in other institutions, and additional direct health expenditures). Almost all studies used health cost databases to obtain direct cost information for the different diseases. Usually, annual expenditure numbers were available and inflation had to be considered (Ding et al., 2016).

In addition, some studies also looked at indirect costs which refer to the economic output lost due to absenteeism, illness-related work-loss, or premature death. The three most common approaches to estimate those are the friction cost approach, the human capital approach, and the value of statistical life lost approach (Ding et al., 2016).

The fourth and fifth steps of calculating the PAFs and applying them to the costs of the diseases follow the same procedure in all studies. More detailed information on the calculation is presented in chapter seven. Many studies conducted sensitivity analyses to check for the robustness of the results. Overall, the health costs have been estimated for numerous regions with the majority of studies focusing on North America. Due to the varying contexts and the previously outlined differences in defining physical activity and including diseases, there were considerable differences between the estimated economic burden of physical inactivity for a country.

All studies provided a total amount of the annual health care costs attributed to physical activity. However, to compare the results, the percentage of total health care costs represents a more useful measure. The numbers differed between 0.3% for the Czech Republic (Maresova, 2014) and 2.6% for Canada (Katzmarzyk, Gledhill & Shephard, 2000). The majority of estimates ranged between 1% and 2.5% (Ding et al., 2016) of total direct health costs of a country. The health conditions identified by most studies with the highest effect were stroke, coronary heart diseases, and hypertension (e.g., Allender et al., 2007, Janssen, 2012; Zhang & Chaaban, 2013). Only Ding et al. (2016) looked at multiple countries. In their global analysis of 142 countries they used broad estimates but found that physical inactivity had cost health care systems worldwide $53.8 billion in 2013. Krueger et al. (2016) focused on regional variations of the economic burden of physical inactivity in British Columbia and found that social, environmental and economic factors drive regional differences.

The results for indirect costs varied depending on the applied estimation approach. Ding et al. (2016) found in their study productivity losses due to physical inactivity related deaths of $13.7 billion in 2013. In a study from Zhang & Chaaban (2013), the indirect costs were on a similar level as the direct costs, whereas in research from Janssen (2012) and Allender et al. (2007) the indirect costs exceeded the directs costs significantly.

A number of analyses have examined direct health costs of physical inactivity jointly with other risk factors such as smoking (Krueger, Turner, Krueger & Ready, 2014; Scarborough et al., 2011), alcohol consumption (Scarborough et al., 2011) and obesity (Colditz, 1999; Chenoweth & Leutzinger et al., 2006; Katzmarzyk, 2011; Katzmarzyk & Janssen, 2004; Popkin, Kim, Rusev, Du & Zizza, 2006). While the findings for physical inactivity were considerably lower compared to the other behavioral risk factors, it should be noted that being physically inactive contributes at least partially to the economic costs of obesity and hence those costs can not be entirely separated.

One last research stream deals with the projection of costs of inactivity in the future. Kalbarczyk & Mackiewicz-Łyziak (2019) looked specifically at older people and estimated how physical inactivity could impact long-term care costs. They projected how costs might develop until 2060 in Poland. Depending on the used measure, they found that the savings from increasing physical activity range between 0.4% and 1.2% of GDP. Cadilhac et al. (2011) conducted a simulation model to estimate the savings that a 10% reduction in physical inactivity could create for Australia. The findings indicated savings in multiple areas and a reduction in health costs by AUD96 million. Lee et al. (2017) applied a computational simulation model representing all US children between 8-11 years. Their results revealed that if the current activity rate of 31.9% could be increased to 50%, it would result in health

cost savings of $8.1 billion and reduced productivity losses of $13.8 billion over the lifetime of the children.

3.4.3 Summary and contribution of chapters six and seven

From a micro-economic perspective, the existing literature indicates that physically active individuals do incur considerably lower health care costs compared to their inactive peers. The relevant body of research can be divided into two streams. The first stream looks at the effect of physical activity interventions and how health care costs have changed for the participants. The second stream uses population-wide data and estimates the effect of physical activity on health care costs. Both approaches have caveats. Results of the first stream are difficult to generalize as the focus lays on specific interventions with often only small samples. For the second stream, the causal effect of physical activity on health care costs is often difficult to estimate. In general, the estimates of health costs savings from physical activity interventions often prove to be significantly higher compared to the estimates of population-wide data. The results also differ between health conditions and socio-demographic characteristics. Especially for older people, cost savings are considerably higher. However, with many studies using general health costs without differentiating between insurance payments and individual own payments, the actual economic burden for people remains unclear.

Chapter six aims to close the research gap by estimating the effect of physical activity on out-of-pocket health costs. The study uses a European dataset of 16 countries with a particular focus on the elderly (50 years and older). The applied two-part models show significant cost savings for both men and women across Europe and a significantly lower economic burden especially for people who are active once a week.

The macro-economic perspective investigates the economic burden of physical inactivity for the total health care system. Previous studies have used the comparative risk assessment method and found an economic burden between 0.3% and 2.6% of total health costs. However, the existing research has only looked at one point in time, and the economic burden was only rarely estimated for specific socio-demographic groups. In chapter seven, the development of inactivity costs in Germany over 13 years is outlined. Furthermore, projections how the costs will develop until 2060 because of an aging society are provided. In addition, the savings if short-term reductions in physical inactivity could be achieved are estimated. The results show a constant increase of per capita health costs due to physical inactivity over the next 40 years and reveal the importance of promoting physical activity in particular for older age-groups.

3.5 Input - Outcome

The direct relationship between public spending to promote physical activity and monetary health outcomes has not been examined in existing research because of two reasons. First, data on the actual spending directed to improve physical activity in a region is often difficult to obtain since many public accounts are not differentiating between the purposes and second, the establishment of a causal effect to the output of increased physical activity is challenging given that the effects are often lagged and highly heterogeneous.

Even in other public spending areas such as health or education those analyses are often limited to specific regions or expenditure categories. For example, on the micro-level, Jackson, Johnson and Persico (2015) investigated school spending in the United States and found that a 10% increase in per-pupil spending can lead to 7% higher wages. Brown (2016) estimated the return on investment of public health expenditure in a California county by conducting a review of existing studies and then monetarized the findings of the input-output relationship. They found that the return on investment from every $1 spent was between $67.07 and $88.21.

For physical activity, the only study estimating the return on investment values for public expenditure on physical activity is currently conducted by Pawlowski, Steckenleiter, Wallrafen & Lechner (2019). However, instead of health outcomes, their focus is on labor market effects. By applying matching-techniques, the authors determine the causal effect of regional sport-related spending on labor market outcomes. Their preliminary results indicate that higher expenditure levels lead to a 7% higher additional household net income.

With regard to health outcomes, economic evaluations are often limited to specific interventions to improve physical activity. Previous research has applied cost-benefit analyses to infrastructure investment such as transport infrastructure or green spaces (Cavill et al., 2008; Vandermeulen et al., 2011; Wang et al. 2005), worksite physical activity programs (Proper et al., 2004; van Dongen et al., 2011) or public health strategies (Benmarhnia et al., 2017). The results indicated, independent from the investment, positive cost-benefit ratios for all the investigated interventions. However, the results were sensitive to the applied time-frame, and the costs considered. Overall, the evidence regarding the input-outcome relationship is scarce. The small body of research on this relationship for other public investments indicates the difficulties of establishing such a relationship, and in the context of public health such estimations are in particular difficult (Brown, 2016). Consequently, the following chapters focus on different contributions to the evidence-base of the HROI framework instead of estimating a direct ROI value of public health investments.[1]

[1]The following four chapters are not included in this version of the dissertation as the copyrights lie with the respective journals.

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4 The relationship between sport-related government spending and sport and exercise participation: the role of funding size, period, and consistency

Dallmeyer, S., Wicker, P., & Breuer, C. (2018). The relationship between sport-related government spending and sport and exercise participation: the role of funding size, period, and consistency. *International Journal of Health Promotion and Education, 56*(4-5), 237-247.

Abstract

Previous research investigated how government spending helps to promote sport participation in the population while relying on average funding figures. The aim of the study is to examine the relationship between sport-related government spending and sport and exercise participation in more detail by specifically looking at the role of funding size, period, and consistency. Individual-level data from the 2011 German Socio-Economic Panel ($n = 17,319$) are combined with state-level data including government spending on sport facilities, swimming pools, and general sport promotion for all 16 states. Multi-level models were estimated to examine how government spending and individual factors are related to regular sport and exercise participation (i.e., at least once per week). The results show that average funding is not significantly related to sport participation except for swimming pool spending over a 10- and 15-year period. Consistent spending on sport facilities is positively associated with participation in sport and exercise, while inconsistent spending on pools has a positive effect. The findings suggest that the role of funding size and consistency differs among the three types of sport-related spending. If state governments want to promote public health through participation in sport and exercise, spending on facilities should be consistent, while spending on swimming pools should occur large in size and allowing for some inconsistencies.

Keywords: Public funding; Sport participation; Health promotion; Multi-level modelling

5 Public expenditure and sport participation: An examination of direct, spillover, and substitution effects

Dallmeyer, S., Wicker, P., & Breuer, C. (2017). Public Expenditure and Sport Participation: An Examination of Direct, Spillover, and Substitution Effects. *International Journal of Sport Finance, 12*(3), 244-264.

Abstract

This study performs a comprehensive analysis of the relationship between various types of government spending and individual sport participation. By combining individual data from the German Socio-Economic Panel with expenditure data of the federal states for the period 2003-2011, direct (i.e. sport facilities, pools, general sport promotion), potential spillover (i.e. education, health, streets, public transport, environment), and substitution effects (i.e. culture) on regular sport participation are analyzed. The results of probit models reveal positive effects for direct sport-related public expenditure on sport facilities and swimming pools in the same year. While spillover effects could be observed for expenditure on streets and transport infrastructure, substitution effects were not identified. The results remain relatively robust when using three-year averages or relative measures of the expenditure variables. One implication for policy makers is that spillover effects from spending not directly targeted at sport can also facilitate regular sport participation.

Keywords: Government spending; Public finance; Physical activity; Sport promotion

6 The relationship between physical activity and out-of-pocket health care costs of the elderly in Europe

Dallmeyer, S., Wicker, P., & Breuer, C. (In press). The relationship between physical activity and out-of-pocket health care costs of the elderly in Europe. *European Journal of Public Health.*

Abstract

Background: Increasing health care costs represent an economic burden placed on individuals across many European countries. Against this backdrop, the aim of this study was to examine the relationship between participation in physical activity and out-of-pocket health care costs in Europe. **Methods:** Individual data from the cross-national Survey of Health, Ageing and Retirement (SHARE; n = 94,267) including 16 European countries were utilized. Two-part models were estimated to investigate how different levels of participation frequency in physical activity are related to out-of-pocket costs for people aged 50 years and older. **Results:** Only participation in physical activity more than once a week significantly decreases the probability of incurring any out-of-pocket costs. However, all frequencies of physical activity significantly reduce the level of costs, with the highest savings being generated by participation once a week. The results reveal higher savings for men compared to women. **Conclusion:** Physical activity can be a useful policy instrument to reduce the economic burden of out-of-pocket health care costs for an aging population in Europe. Public officials should primarily promote physical activity interventions targeting older people who are not active at all.

Keywords: Health care costs; Economic burden; Aging population; Costs of inactivity

7 How an aging society affects the economic costs of inactivity in Germany: empirical evidence and projections

Dallmeyer, S., Wicker, P., & Breuer, C. (2017). How an aging society affects the economic costs of inactivity in Germany: empirical evidence and projections. *European Review of Aging and Physical Activity, 14*(1), 18-26.

Abstract

Background: Aging societies represent a major challenge for health care systems all over the world. As older people tend to be more physically inactive, economic costs of inactivity are likely to increase notably. The present study aims to investigate this relationship between an aging society and economic costs of inactivity using the example of Germany. **Methods:** Using data from the German Socio-Economic Panel, this study applied the comparative risk assessment method developed by the WHO to estimate the direct costs of inactivity for the period 2001–2013 differentiated by gender-specific age-groups (15–29; 30–44; 45–64; 65+). Based on population statistics predicting the aging of the German population for the years 2014–2060, this research projects the development of future costs of inactivity and potential effects of interventions promoting physical activity among the German population. **Results:** The results reveal an increase in the level of physical activity during the observed period (2001–2013) which compensated the negative effect of aging and resulted in a decline of inactivity costs. The projections for the years 2014–2060 indicate a constant increase in direct per capita costs until 2060 because of an aging society. Scenarios indicating how a short-term reduction of physical inactivity impacts costs of inactivity reveal the crucial role of the oldest age-group in this context. **Conclusion:** The findings indicate that the aging of the German population demands further actions and initiatives to promote physical activity, especially for the oldest age-group.

Keywords: Costs of inactivity; Aging societies; Projections; Physical activity; Public health

8 Conclusion and outlook

This thesis has developed an HROI framework for public investments in physical activity and provides empirical evidence to different parts of this framework. The framework builds on previous research of SROI analyses of physical activity (e.g., Davies et al., 2019), while adopting a distinct health economic perspective in describing the relationship between inputs, outputs, and health-related outcomes. Consequently, physical activity within the framework refers only to activities meeting the criteria stipulated by the WHO (2010) for health-enhancing effects, namely intensity, frequency, and duration (e.g., sport participation, exercise).

The two main research questions of the thesis relate to input-output and output-outcome relationships. Regarding the input-output relationship, the HROI framework distinguishes between a direct relationship for public investments with the specific purpose of promoting physical activity and an indirect relationship for public investments which affect physical activity indirectly through spillover effects. The systematic literature review reveals that previous research on the input-output relationship is limited and has produced just inconclusive findings. The empirical evidence presented in chapters four and five insofar adds several new insights. It is demonstrated that the effects for spending specifically on sports, as a form of direct spending, are most likely time lagged and that particularly investments in sport infrastructure can be associated with higher levels of sport participation. Moreover, chapter five indicates that in addition to governmental spending directly-related to physical activity, spillover effects for public spending on transport infrastructure should be considered. Furthermore, it is shown that negative substitution effects for investments in cultural areas cannot be expected.

For public officials, the evidence provided from the input-output relationships helps to guide decision-making about the allocation of financial resources to promote participation in physical activity by emphasizing the important role of sport infrastructure and outlining how investment in other areas, such as education or transport infrastructure, may prove beneficial as well. The results also indicate that considering different timeframes is necessary when evaluating those investments, given that the effects are most likely lagged.

A health economic evaluation of the output-outcome relationship of the HROI framework shows how participation in physical activity may translate into economic benefits in terms of lower health cost incurrence. The HROI framework insofar distinguishes between effects on the micro- and macro-level. Although the existing literature for both levels is considerable, the systematic literature review demon-

strates a need for evidence to describe the economic burden of physical inactivity for specific health costs measures and in the context of changing demographics.

Chapter six contributes to the micro-level and focusses on the relationship between participation frequency in physical activity and out-of-pocket health costs of the elderly. Therefore, out-of-pocket costs are considered a more accurate measure of the individual's economic burden compared to previously used measures of health costs. The results show that older people can significantly reduce their out-of-pocket costs by becoming physically active. Thus, this study's specific focus on an older cohort reveals a potential effective mechanism to lower the economic burden as societies age. Chapter seven estimates the costs of physical inactivity from a macro-perspective. The application of the comparative risks assessment method reveals that the costs of inactivity in Germany are in fact substantial and rank on a level similar to previous estimates from different countries. Further, the study demonstrates the development of costs of inactivity based on population projections until 2060 and shows that the aging of societies will significantly increase the costs of inactivity for the health care system in Germany. Finally, the study indicates the economic effectiveness of reducing the rate of inactivity among the population, in particular for older individuals.

A direct estimation of the input-outcome relationship proves rather difficult due to the confluence of the available data on the micro- and macro-level, an identification problem, and an unknown lag of effects. Accordingly, basically no empirical evidence exists for public investments in physical activity. Previous research has only estimated the relationship for singular public interventions.

The thesis contributes to the field of public health and health economics in multiple ways. First, the developed HROI framework enables future researcher to establish an evidence-base for every relationship within the framework. With public investments in physical activity often being a political target for budget cuts, the findings may help to defend public efforts geared towards promoting physical activity, as now they can outline necessary corrections of market failures in terms of externalities (e.g., increasing economic burden for health systems) and underprovisions of public goods (e.g., infrastructure required for physical activity participation). Also, the provided evidence allows public officials to undertake economic comparison of investments in physical activity to other public health investments, such as common prevention strategies of unhealthy behavior (e.g., smoking, alcohol drinking, or unhealthy eating). A further contribution lays in the applicability of the HROI framework to evaluate specific public health strategies. Similar to the study from Benmarhnia, Dionne, Tcchouaket, Fansi, and Brouselle (2017), an HROI analysis could help governments to evaluate long-term public health strategies by determining their economic effectiveness. Finally, the findings indicate how increasing participation in physical activity can well assist governments in dealing with

future challenges for public health care systems, particularly those associated with an aging populations.

It should be noted that, by no means, the author suggests that public officials should allocate public resources based solely on considerations of economic efficiency and happen even at the expense of equity or fairness. Instead, the framework should be understood as a tool to assist rational-decision making of public health officials, designed to help tailor public health strategies while leaving equity-efficiency trade-offs to respective political priorities.

The developed HROI framework of physical activity and the four academic papers reveal avenues for future research. First, applying the HROI framework to estimate an actual HROI ratio by comprising existing evidence from previous studies similar to Davies et al. (2019) in their SROI analysis is beyond the scope of this thesis. To simplify estimations while simultaneously retrieving politically relevant information, future research should start by focusing only on specific health outcomes when determining an HROI ratio. Second, estimating the input-outcome relationship directly is difficult due to aforementioned reasons. The study from Pawlowski et al. (2019) on the relationship between public expenditure on sports and labor market outcomes represents a first indication how such analyses can yet be conducted. A similar approach applied to economic health outcomes could provide some first insights. Regarding the input-output relationship, future research should aim for establishing a causal relationship between public expenditure and physical activity by, for example, applying matching techniques or using panel data. In addition, more detailed data on the macro-level would improve the identification of the effect. For the output-outcome relationship, future research might look at the diminishing effect of physical activity participation on health costs. Evidence regarding the appropriate level of physical activity participation is needed to maximize health economic outcomes.

Abstract

Public investments in physical activity, particularly in times of fiscal austerity, are regular of targets governmental budget cuts. From a health economic perspective, this is especially problematic as physical activity, for all its well-documented health benefits, actually represents an appropriate mechanism to reduce the increasing costs of public health systems. An estimation of a return on investment of public spending on physical activity thus may serve as a useful point of reference for policy makers when allocating financial resources.

Drawing on existing economic evaluation methods, the present thesis develops a health return on investment (HROI) framework, describing the relationship between input (public investments), output (physical activity), and outcome (health costs). Moreover, in chapters four to seven, four academic papers are presented, providing new empirical evidence to the different relationships of such HROI framework.

In chapters four and five, the focus is on the input-output relationship. Chapter four takes a look at the effect of sport-related public investments on sport participation. The results indicate that the effects are most likely lagged and that, in particular, investments in sport infrastructure do positively affect sports participation. Chapter five demonstrates that, in addition to sport-related spending, public investments in other areas have to be considered. For example, a positive relationship between transport infrastructure and sport participation can be demonstrated.

Capters six and seven then concentrate on the output-outcome relationship. Chapter six investigates the effect of physical activity on out-of-pocket health costs of the elderly. The results show that older people can in fact significantly reduce their health costs by becoming physically active. Chapter seven analyzes the effect of physical activity on health costs from a macro-perspective. Applying the comparative risk method allows to estimate the costs of inactivity for the period 2001-2013. Moreover, the study reveals that demographic changes are likely to increase the costs of physical inactivity.

Overall the thesis represents a first step in measuring the HROI of public investment in physical activity. It adds to the existing empirical evidence on two of the core relationships of the HROI framework by specifically considering the transformative context of an aging society.

Kurzfassung

Öffentliche Investitionen zur Förderung von körperlicher Aktivität sind oftmals umstritten und häufig Bestandteil von Budgetkürzungen öffentlicher Haushalte. Dies ist insbesondere aus gesundheitsökonomischer Perspektive problematisch, da körperliche Aktivität aufgrund der nachgewiesenen positiven Effekte auf die individuelle Gesundheit ein geeignetes Instrument darstellt, um die Kosten für Gesundheitssysteme zu reduzieren. Eine Berechnung des *return on investment* öffentlicher Investitionen in körperliche Aktivität kann daher für politische Entscheidungsträger eine wichtige Orientierung bei der Vergabe finanzieller Mittel darstellen.

Die vorliegende Dissertation entwickelt zunächst auf Basis bestehender Evaluationsmethoden ein *Health-Return on Investment Modell (HROI)*, das die Beziehung zwischen dem *Input* (öffentliche Investitionen), dem *Output* (körperliche Aktivität) und dem *Outcome* (Gesundheitskosten) beschreibt. Anschließend werden in den Kapiteln vier bis sieben vier Studien dargestellt, die die empirische Evidenzlage zu verschiedenen Zusammenhängen innerhalb des Modells erweitern.

Kapitel vier und fünf legen dabei den Fokus auf die *Input-Output-Beziehung*. In Kapitel vier wird der Zusammenhang zwischen spezifisch auf Sport zielende öffentliche Ausgaben und sportlicher Aktivität untersucht. Die Ergebnisse deuten darauf hin, dass die Effekte häufig verzögert auftreten und insbesondere Investitionen in Sportinfrastruktur einen positiven Einfluss auf die sportliche Aktivität besitzen. Kapitel 5 zeigt, dass zusätzlich zu sport-spezifischen Investitionen auch Ausgaben in anderen Bereichen Einfluss auf die Sportpartizipation haben können. So können positive Effekte für öffentliche Investitionen in Transportinfrastruktur nachgewiesen werden. Kapitel sechs und sieben beschäftigen sich mit der *Output-Outcome-Beziehung*. In Kapitel sechs wird der Einfluss körperlicher Aktivität auf *Out-of-pocket-Gesundheitskosten* von Senioren geschätzt. Die Ergebnisse verdeutlichen, dass ältere Menschen ihre Gesundheitsausgaben signifikant durch körperliche Aktivität verringern können. Kapitel sieben analysiert den Einfluss von körperlicher Aktivität auf Gesundheitskosten aus einer Makroperspektive. Durch Anwendung der komparativen Risikomethode wird die Entwicklung der Kosten körperlicher Inaktivität in Deutschland für die Jahre 2001-2013 geschätzt. Zusätzlich zeigt die Studie, dass die Kosten körperlicher Inaktivität aufgrund einer immer älter werdenden Bevölkerung erheblich steigen könnten.

Insgesamt stellt die Dissertation einen ersten Beitrag zur Messung des HROI von körperlicher Aktivität dar. Der bestehende Forschungsstand zur *Input-Output-* und *Output-Outcome-Beziehung* innerhalb des Modells wird erweitert und dabei insbesondere um das Element des demographischen Wandels ergänzt.