Conditions for the structural and environmental promotion of physical activity

Zur Erlangung des akademischen Grades einer

DOKTORIN DER PHILOSOPHIE

(Dr. phil.)

von der KIT-Fakultät für Geistes- und Sozialwissenschaften des

Karlsruher Instituts für Technologie (KIT)

angenommene

DISSERTATION

von

Laura Wolbring

KIT-Dekan: Prof. Dr. Michael Mäs

1. Gutachter: Prof. Dr. Hagen Wäsche

2. Gutachter: Prof. Dr. Alexander Woll

Tag der mündlichen Prüfung: 19.07.2024

Acknowledgments

I would like to express my sincere gratitude to my supervisors, Hagen Wäsche and Alexander Woll, for their unwavering support, invaluable guidance, and constant encouragement throughout my doctoral journey. Their expertise, insights, and dedication have been instrumental in shaping the direction of my research and in helping me overcome challenges along the way.

I would also like to acknowledge the indispensable contributions and feedback of my coauthors. Their collaborative efforts have substantially enhanced the scope and quality of this research project.

I extend my appreciation to my colleagues from the Institute of Sports and Sports Science at Karlsruhe Institute of Technology. Engaging in insightful discussions within this academic community has significantly facilitated the evolution of my ideas. Lena Panter deserves a special note. Her emotional support, empathy, and encouragement provided a stabilizing influence during the dynamic phases of this journey.

I am grateful for the financial support I received from the Graduate Funding from the German States. This scholarship has played a pivotal role in enabling the pursuit of this academic endeavor.

Finally, I express my gratitude to my family and friends for their unconditional support throughout this time. A special acknowledgment is reserved for my parents and my brother. Your consistent assurance and encouragement have provided me with the confidence to pursue this endeavor. I would also like to thank Peter for his continuous support and companionship during this journey.

Summary

Previous research has shown that regular physical activity has a positive impact on the physical and mental health of people of all ages. However, only a small proportion of the population achieves the recommended physical activity levels. In Germany, about 80 % of children and adolescents and 40 % of adults are not sufficiently active. Physical inactivity is not only responsible for 10 % of all deaths but is also associated with immense economic burden. According to estimates, the annual cost in Germany amounts to approximately 2.7 billion euros.

To counteract these developments, the German National Recommendations for Physical Activity and Physical Activity Promotion were published in September 2016. The World Health Organization also recently published updated physical activity guidelines. However, there is still a lack of an efficient dissemination strategy aimed at sustainable physical activity promotion throughout the population.

In addition to individual behavioral interventions, special consideration should be given to measures that aim to change structures. These have recently become increasingly important in promoting physical activity behavior at the population level. To influence individual health-promoting behavior, living environments should be designed in such a way that they automatically encourage people to be physically active. This is based on the social-ecological paradigm, which assumes that human behavior takes place in interrelated and complex ecological systems. Especially the integration of socially disadvantaged population groups is a major challenge in the context of physical activity promotion, where structural measures, such as creating physical activity-friendly environments, are a promising approach.

Despite the relevance of structural interventions to promote sport and physical activity at the population level, the evidence base concerning these approaches is rather scarce. To generate new insights in this regard, the aim of the doctoral thesis is to analyze social and environmental structures of sport and physical activity. The findings provide a basis for the development of systematic and sustainable strategies for the promotion of sport and physical activity. This cumulative work is based on three scientific studies, which resulted in four publications. To address the central topic of the

dissertation in a multifaceted and comprehensive way, we chose a broad theoretical and methodological approach.

In our **first publication**, we addressed the problem of how national physical activity recommendations can be translated into practice involving change agents of physical activity promotion. Change agents, such as teachers, politicians, sport club representatives, or urban planners, can influence structures of physical activity promotion as decision makers, knowledge brokers, or role models at different administrative levels and in different sectors of society. To find out which conditions have to be fulfilled from the change agents' perspectives to implement physical activity recommendations, we investigated the following questions: (a) What are the attitudes and knowledge of change agents regarding physical activity and physical activity promotion and (b) what are their needs regarding the implementation of physical activity recommendations in their specific setting? In order to answer these questions, 21 expert interviews were conducted with change agents from different sectors of society. The interviews were recorded, transcribed, and analyzed using qualitative content analysis. The results showed that the perceived importance of physical activity and physical activity promotion as well as the knowledge of the change agents about the national physical activity recommendations varied strongly depending on the sector of society. We identified nine themes that covered the change agents' needs for the implementation of physical activity recommendations: strengthening of political will and cooperation, availability of public space for physical activity, change in awareness and health education, professional qualification, financial incentives, development of physical activity-promoting programs and structures, provision of resources, bridging the theory–practice gap, and knowledge of physical activity recommendations. Based on the identified topics, we were able to derive specific recommendations for action on how a dissemination strategy of national physical activity recommendations involving relevant change agents should be designed.

However, the involvement of change agents is not sufficient to create sustainable structures that promote physical activity. In addition, systematic and intersectoral networking and cooperation is needed to combine different core competencies and resources and to build capacities. The basic idea is that population-related health problems, such as physical inactivity, are very complex and multifaceted. However, public resources to address such challenges are often scarce. Thus, cooperation of change

agents representing public and private organizations from diverse sectors is essential. In our **second and third publication**, we focused on socio-spatial cooperation networks of sport-providing and sport-coordinating organizations. To derive insights into the emergence, nature, and further development of the networks, our research question was: What are (a) structural properties and (b) conditions of cooperation in community networks of physical activity promotion? In our **second publication**, we investigated a community cooperation network using quantitative descriptive methods of network analysis and stochastic analyses of network modeling. In our **third publication**, we compared the network from the second publication with another community network with regard to existing structures and conditions of cooperation to be able to identify superordinate mechanisms. The results showed that similar structures and conditions of cooperation could be identified in both networks. In each case, the networks were highly fragmented with a low number of realized ties and an inequality of cooperative activity. The community sports administrations had the highest number of cooperative relationships and thus occupied central positions within the networks. Regarding the conditions of cooperation, the analyses showed that cooperation in both networks often took place in triangular structures and revolved around a few central actors. In addition, organizations from different sectors cooperated more frequently with each other than organizations from the same sector. Based on the results, we derived recommendations for the development and most efficient management of the networks enabling a sustainable promotion of physical activity at the community level.

In our **fourth publication**, we investigated the socio-structural determinants of physical activity behavior in children and adolescents. In order to develop successful interventions to promote physical activity, knowledge is needed about the factors that influence this behavior. Previous research has shown that, in addition to individual factors, structural factors, such as socioeconomic status, social support, and the physical environment, play an important role. To examine the interaction of these structural determinants in more detail, the following question was investigated: What influence do parental socioeconomic status, social support from family and peers, and the physical environment have on the physical activity behavior of children and adolescents? In particular, we wanted to analyze how structural and environmental conditions affect physical activity behavior, taking social inequality into account. To answer this question, we used cross-sectional data from the second wave (2014-2017) of the Motorik-

Modul Study (MoMo). The sample included children and adolescents aged 6-17 years. Physical activity was assessed device-based by accelerometers worn by the participants for seven consecutive days. Results showed that among children, only social support had a direct effect on physical activity behavior. Socioeconomic status had an indirect effect on physical activity via social support. In adolescents, all three socio-structural determinants had a direct effect on physical activity behavior, with social support having the largest effect. Socioeconomic status influenced physical activity both directly and indirectly via social support and the physical environment. The results suggest that social support from family and friends, in particular, plays an important role with regard to the physical activity behavior among young age groups. The knowledge gained about the interplay and the relevance of the considered determinants enables the planning of effective and sustainable interventions on a socio-structural level. The results can also be used as a basis for developing measures to better integrate socially disadvantaged population groups in the context of physical activity promotion.

In this doctoral thesis, a variety of perspectives on the conditions of a structural and environmental promotion of physical activity are examined in a multi-theoretical and multi-method approach. Different levels (national, community, individual) as well as different structural dimensions (infrastructure, relationship structures, structures of social inequality) are considered. This results in a multidimensional picture, which expands the current state of knowledge through new approaches in the field of sport and physical activity promotion. The findings of the **first publication** of this work enable the development of an evidence-based strategy for the dissemination of national physical activity recommendations involving various change agents of physical activity promotion. The **second and third publications** reveal community cooperation structures of sport and physical activity providers and enable an understanding of how cooperation works in the context of sport and physical activity promotion. Based on the results, recommendations can be derived for the development and most efficient management of interorganizational networks so that physical activity can be promoted sustainably and systematically at the community level. The results of the **fourth publication** emphasize the importance of close social relationships with family and friends as well as social capital as a source of social support for the physical activity behavior of young age groups. To contribute to equal health opportunities, appropriate measures at the

level of social integration and physical environment are needed to enable socially disadvantaged children and adolescents to participate in sport and physical activity. The central results are discussed and put into a broader context in the last chapter of this work. In doing so, we also present implications for future research.

Zusammenfassung

Eine Vielzahl von Studien konnte zeigen, dass regelmäßige körperlich-sportliche Aktivität bei Menschen jeden Alters einen positiven Einfluss auf die physische wie auch mentale Gesundheit hat. Die empfohlene Bewegungsdosis wird jedoch nur von einem geringen Teil der Bevölkerung erreicht. In Deutschland sind ca. 80 % der Kinder und Jugendlichen und 40 % der Erwachsenen nicht ausreichend aktiv. Körperliche Inaktivität ist nicht nur für 10 % aller Todesfälle verantwortlich, sondern auch mit immensen volkswirtschaftlichen Kosten verbunden. Schätzungen zufolge beläuft sich allein in Deutschland die Summe auf ca. 2,7 Milliarden Euro pro Jahr.

Um diesen Entwicklungen entgegenzuwirken, wurden im September 2016 die Nationalen Empfehlungen für Bewegung und Bewegungsförderung für Deutschland herausgegeben. Auch die Weltgesundheitsorganisation veröffentlichte kürzlich aktualisierte Bewegungsrichtlinien. Bisher mangelt es jedoch an einer effizienten Disseminierungsstrategie, die auf eine bevölkerungsübergreifende und nachhaltige Bewegungsförderung abzielt.

Neben individuellen verhaltensbezogenen Interventionen sollten hierbei lebensweltbasierte und verhältnisbezogene Maßnahmen, die auf die Veränderung von Strukturen abzielen, besondere Berücksichtigung finden. Diese gewinnen zur Förderung des Bewegungsverhaltens auf Bevölkerungsebene in letzter Zeit zunehmend an Bedeutung. Um individuelles gesundheitsförderliches Verhalten zu beeinflussen, sollten Lebenswelten so gestaltet sein, dass sie automatisch zu mehr Bewegung animieren. Dies basiert auf dem sozial-ökologischen Paradigma, welches davon ausgeht, dass menschliches Verhalten in sich gegenseitig beeinflussenden komplexen ökologischen Systemen stattfindet. Besonders die Integration sozial benachteiligter Bevölkerungsgruppen stellt im Kontext der Bewegungsförderung eine große Herausforderung dar, wobei lebensweltbasierte Maßnahmen, wie z.B. ein bewegungsförderlich gestaltetes Wohnumfeld, ein vielversprechender Lösungsansatz sind.

Trotz der Relevanz struktureller Maßnahmen zur Sport- und Bewegungsförderung auf Ebene der Bevölkerung ist die Evidenzlage hinsichtlich dieser Ansätze bisher gering ausgeprägt. Um diesbezüglich neue Erkenntnisse zu generieren, ist das Ziel dieser Dissertation, die sozialen und lebensweltlichen Strukturen von Sport und Bewegung

zu analysieren. Die gewonnenen Erkenntnisse bilden die Grundlage für die Entwicklung systematischer und nachhaltiger Strategien zur Sport- und Bewegungsförderung. Die kumulative Dissertation basiert auf drei wissenschaftlichen Studien, aus welchen vier Publikationen entstanden sind. Um die zentrale Thematik dieser Arbeit möglichst facettenreich und umfassend zu beleuchten, wurde ein breiter theoretischer und methodischer Ansatz gewählt.

In unserer **ersten Publikation** befassten wir uns mit der Problemstellung, wie nationale Bewegungsempfehlungen unter Einbezug relevanter Multiplikator:innen der Bewegungsförderung in die Praxis gelangen können. Multiplikator:innen, wie z.B. Lehrer:innen, Politiker:innen, Vereinsvertreter:innen oder Stadtplaner:innen, können als Entscheidungsträger:innen, Wissensvermittler:innen oder Rollenvorbilder auf verschiedenen Ebenen und in unterschiedlichen Gesellschaftsbereichen Einfluss auf bewegungsförderliche Strukturen nehmen. Um herauszufinden, welche Bedingungen aus der Sicht von Multiplikator:innen erfüllt sein müssen, damit Bewegungsempfehlungen in die Umsetzung gelangen können, wurde den folgenden Fragestellungen nachgegangen: (a) Was sind Einstellungen und Kenntnisse von Multiplikator:innen bezüglich Bewegung und Bewegungsförderung und (b) was sind ihre Bedarfe hinsichtlich einer Umsetzung der Bewegungsempfehlungen in ihrem spezifischen Setting? Zur Beantwortung der Fragestellungen wurden 21 leitfadengestützte Expert:inneninterviews mit Multiplikator:innen aus verschiedenen Gesellschaftsbereichen durchgeführt. Die Interviews wurden aufgenommen, transkribiert und mittels qualitativer Inhaltsanalyse ausgewertet. Die Ergebnisse zeigten, dass die wahrgenommene Wichtigkeit von Bewegung und Bewegungsförderung sowie das Wissen der Multiplikator:innen über die nationalen Bewegungsempfehlungen je nach Gesellschaftsbereich stark variierten. Insgesamt wurden neun übergreifende Handlungsfelder identifiziert, welche die Bedarfe der Multiplikator:innen zur Umsetzung der Bewegungsempfehlungen abdecken: Stärkung von politischem Willen und Kooperation, Verfügbarkeit von öffentlichen Räumen für Bewegungsförderung, Bewusstseinsänderung und Gesundheitsbildung, berufliche Qualifizierung hinsichtlich Bewegungsförderung, finanzielle Anreize, Entwicklung bewegungsförderlicher Programme und Strukturen, Bereitstellung von Ressourcen (finanziell, räumlich, personell), Überbrückung des Theorie-Praxis Grabens und Bekanntmachung der Bewegungsempfehlungen. Auf Basis der identifizierten Themen konnten wir konkrete Handlungsempfehlungen dafür ableiten, wie eine nationale

Disseminierungsstrategie der Bewegungsempfehlungen unter Einbeziehung relevanter Multiplikator:innen gestaltet sein soll.

Für eine nachhaltige Gestaltung bewegungsförderlicher Strukturen reicht die Einbindung von Multiplikator:innen nicht aus. Zusätzlich bedarf es einer systematischen und intersektoralen Vernetzung und Zusammenarbeit dieser, um verschiedene Kernkompetenzen sowie Ressourcen zu vereinen und Kapazitäten aufzubauen. Die Grundidee dabei ist, dass bevölkerungsbezogene Gesundheitsprobleme, wie körperliche Inaktivität, sehr komplex und vielschichtig sind. Die öffentlichen Mittel, um solche Herausforderungen zu lösen, sind jedoch häufig knapp bemessen, sodass die Zusammenarbeit von Multiplikator:innen als Repräsentant:innen öffentlicher und privater Organisationen diverser Sektoren unerlässlich ist. Daher standen in der **zweiten und dritten Publikation** der Dissertation sozialräumliche Kooperationsnetzwerke von sportanbietenden und sportkoordinierenden Organisationen im Fokus. Um Erkenntnisse zur Entstehung, Beschaffenheit und Weiterentwicklung der Netzwerke ableiten zu können, lautete die Fragestellung: Was sind (a) strukturelle Eigenschaften und (b) Bedingungen der Kooperation in kommunalen Netzwerken der Bewegungsförderung? In unserer **zweiten Publikation** untersuchten wir ein kommunales Kooperationsnetzwerk mit quantitativen deskriptiven Verfahren der Netzwerkanalyse und stochastischen Analysen der Netzwerkmodellierung. In unserer **dritten Publikation** verglichen wir das Netzwerk aus der zweiten Publikation mit einem weiteren kommunalen Netzwerk hinsichtlich vorhandener Strukturen und Bedingungen der Kooperation, um übergeordnete Mechanismen identifizieren zu können. Die Ergebnisse zeigten, dass sich in beiden Netzwerken ähnliche Strukturen und Bedingungen der Kooperation feststellen lassen. Es handelte sich jeweils um stark fragmentierte Netzwerke mit einer geringen Anzahl an ausgebildeten Beziehungen und einer Ungleichheit der Kooperationsaktivität. Die kommunalen Schul- und Sportämter hatten die höchste Anzahl an Kooperationsbeziehungen inne und nahmen damit zentrale Positionen innerhalb der Netzwerke ein. Was die Bedingungen der Kooperation betrifft, konnten die Analysen zeigen, dass Kooperation in beiden Netzwerken häufig in Dreieckskonstellationen stattfand und sich um wenige zentrale Akteure drehte. Zudem kooperierten Organisationen unterschiedlicher Sektoren häufiger miteinander als Organisationen aus dem gleichen Sektor. Auf Basis der Ergebnisse wurden Maßnahmen zur Entwicklung und möglichst effizienten

Steuerung der Netzwerke abgeleitet, damit Bewegungsförderung auf kommunaler Ebene nachhaltig gestaltet werden kann.

In unserer **vierten Publikation** untersuchten wir die soziostrukturellen Determinanten des Bewegungsverhaltens von Kindern und Jugendlichen. Um erfolgreiche Interventionen zur Bewegungsförderung entwickeln zu können, bedarf es an Erkenntnissen dazu, welche Faktoren die körperlich-sportliche Aktivität beeinflussen. Bisherige Forschung konnte zeigen, dass neben individuellen Faktoren, auch strukturelle Faktoren, wie der soziökonomische Status, soziale Unterstützung und die physische Umwelt eine wichtige Rolle spielen. Um das Zusammenspiel struktureller Determinanten hinsichtlich des Bewegungsverhaltens von Kindern und Jugendlichen genauer zu betrachten, wurde in der vierten Publikation der folgenden Fragestellung nachgegangen: Welchen Einfluss haben der soziökonomische Status der Eltern, die soziale Unterstützung durch Familie und Freunde und die physische Umwelt auf die körperlich-sportliche Aktivität von Kindern und Jugendlichen? Hierbei sollte insbesondere untersucht werden, wie strukturelle und lebensweltliche Bedingungen, unter der Berücksichtigung von sozialer Ungleichheit, auf das Bewegungsverhalten wirken. Zur Beantwortung der Fragestellung wurde auf Querschnittsdaten aus der zweiten Erhebungswelle (2014-2017) der Motorik-Modul Studie (MoMo) zurückgegriffen. Die Stichprobe umfasste Kinder und Jugendliche im Alter von 6-17 Jahren. Körperlich-sportliche Aktivität wurde objektiv durch Akzelerometer erfasst, welche die Kinder und Jugendlichen an sieben aufeinanderfolgenden Tagen trugen. Die Ergebnisse zeigten, dass bei Kindern nur soziale Unterstützung einen direkten Einfluss auf das Bewegungsverhalten hatte. Der sozioökonomische Status hatte über die soziale Unterstützung einen indirekten Effekt auf körperlich-sportliche Aktivität. Bei Jugendlichen hatten alle drei soziostrukturellen Determinanten einen direkten Einfluss auf das Bewegungsverhalten, wobei die soziale Unterstützung den größten Effekt hatte. Der sozioökonomische Status beeinflusste die körperlich-sportliche Aktivität sowohl direkt als auch indirekt über die soziale Unterstützung und die physische Umgebung. Die Ergebnisse legen nahe, dass vor allem die soziale Unterstützung durch Familie und Freund:innen eine wichtige Rolle hinsichtlich des Bewegungsverhaltens von jungen Altersgruppen spielt. Die gewonnenen Erkenntnisse über das Zusammenspiel und die Relevanz der betrachteten Determinanten hinsichtlich des Bewegungsverhaltens von Kindern und Jugendlichen ermöglichen die Planung effektiver und nachhaltiger Interventionen auf soziostruktureller Ebene. Auch

können auf Basis der Ergebnisse Maßnahmen entwickelt werden, wie vor allem sozial benachteiligte Bevölkerungsgruppen im Rahmen der Bewegungsförderung besser integriert werden können.

In der vorliegenden Dissertation werden in einem multitheoretischen und multimethodischen Ansatz die Bedingungen einer strukturellen und lebensweltlichen Bewegungsförderung aus verschiedenen Perspektiven beleuchtet. Hierbei werden sowohl verschiedene Ebenen (national, kommunal, individuell) als auch verschiedene strukturelle Dimensionen (Infrastruktur, Beziehungsstruktur, Verteilungsstruktur) betrachtet. So ergibt sich ein mehrdimensionales Bild, welches durch neue Ansätze im Bereich der Sport- und Bewegungsförderung den bisherigen Kenntnisstand erweitert. Die Ergebnisse der **ersten Publikation** dieser Arbeit ermöglichen die Entwicklung einer evidenzbasierten Strategie zur Disseminierung nationaler Bewegungsempfehlungen unter Einbezug diverser Multiplikator:innen der Bewegungsförderung. Die **zweite und dritte Publikation** legen kommunale Kooperationsstrukturen von Sport- und Bewegungsanbietern offen und ermöglichen ein Verstehen der Funktionsweise von Kooperation im Kontext der Sport- und Bewegungsförderung. Aus den gewonnenen Ergebnissen lassen sich Empfehlungen zur Entwicklung und möglichst effizienten Steuerung interorganisationaler Netzwerke ableiten, sodass Bewegung auf kommunaler Ebene nachhaltig und systematisch gefördert werden kann. Die Ergebnisse der **vierten Publikation** betonen die Wichtigkeit enger sozialer Beziehungen zu Familie und Freund:innen sowie sozialen Kapitals als Quelle sozialer Unterstützung für das Bewegungsverhalten junger Altersgruppen. Um zu einer gesundheitlichen Chancengleichheit beizutragen, werden entsprechende Maßnahmen auf Ebene der sozialen Integration und physischen Umwelt benötigt, die es sozial benachteiligten Kindern und Jugendlichen ermöglichen, an Sport und Bewegung teilzunehmen. Die zentralen Ergebnisse werden im letzten Kapitel dieser Arbeit diskutiert und in einen übergreifenden Kontext eingeordnet. Hierbei legen wir auch Anknüpfungspunkte für die zukünftige Forschung dar.

Contents

List of Figures

Chapter 1

Chapter 2

Chapter 3

Chapter 4

Chapter 5

List of Tables

Chapter 2

Chapter 3

Chapter 4

Chapter 5

Preface

Parts of this work have been published or have been submitted for publication. The following chapters can be read independently from each other.

Chapter 2: Wolbring, L., Reimers, A. K., Niessner, C., Demetriou, Y., Schmidt, S. C. E., Woll, A., & Wäsche, H. (2021). How to disseminate national recommendations for physical activity: A qualitative analysis of critical change agents in Germany. *Health Research Policy and Systems*, *19*, Article 78. https://doi.org/10.1186/s12961-021-00729-7

Chapter 3: Wäsche, H.*, Wolbring, L.*, & Woll, A. (2021). Physical activity promotion in an urban district: Analyzing the mechanisms of interorganizational cooperation. *PLOS ONE*, *16*(11), Article e0260053. https://doi.org/10.1371/journal.pone.0260053

Chapter 4: Wolbring, L., Schmidt, S. C. E., Niessner, C., Woll, A., & Wäsche, H. (2022). Community networks of sport and physical activity promotion: An analysis of structural properties and conditions of cooperation. *BMC Public Health*, *22*, Article 1966. https://doi.org/10.1186/s12889-022-14383-3

Chapter 5: Wolbring, L., Jekauc, D., Hinz, T., Burchartz, A., Kolb, S., Schmidt, S. C. E., Woll, A., & Wäsche, H. (2024). Socio-structural determinants of physical activity behavior in children and adolescents: The importance of social support. *International Review for the Sociology of Sport*. https://doi.org/10.1177/10126902241266615

**Authors contributed equally to this work*

Chapter 1: General Introduction

Numerous studies have shown that sport and physical activity can prevent non-communicable diseases, such as diabetes mellitus and coronary heart disease, as well as mental health disorders (Reiner et al., 2013). In 2016, the German Federal Ministry of Health published the German National Recommendations for Physical Activity and Physical Activity Promotion (Rütten & Pfeifer, 2016). An update of the World Health Organization guidelines on physical activity and sedentary behavior was launched in 2020 as well (World Health Organization, 2020). World Health Organization (2022a) estimates that one in four adults worldwide (27.5 %) are not sufficiently active. In Germany, approximately 40 % of adults do not achieve the recommended physical activity levels of 150 minutes of moderate-intensity aerobic physical activity or 75 minutes of vigorous-intensity aerobic physical activity (or an equivalent combination of both intensities) throughout the week (Guthold et al., 2018; World Health Organization, 2022b). Among children and adolescents, the percentage is even higher with 80 % of girls and boys that do not meet the 60 minutes of moderate to vigorous physical activity everyday recommended for this age group (Jekauc et al., 2012; Schmidt et al., 2020).

Physical inactivity does not only have individual consequences such as illness and higher mortality rates (Hamer et al., 2017) but also causes high societal costs. In Germany, according to estimates, these costs amount to 2.7 billion euros per year (Ding et al., 2016). Measures and policies to promote sport and physical activity are therefore essential to counteract these developments.

Individual behavioral interventions have proven insufficient to promote physical activity behavior at the population level (Frieden et al., 2010; Sallis et al., 2009). Instead, interventions aimed at changing environmental and structural conditions are gaining increasing attention (Bornstein et al., 2013; Guthold et al., 2018; Heath et al., 2012). The basic assumption is that in order to influence the behavior of the target group, living environments should be designed in such a way that they encourage physical activity and that the active choice is the easier one to make (Bartholomew Eldredge et al., 2016). In its Global Action Plan on Physical Activity, the World Health Organization (2018) calls not only for the provision of individual physical activity programs but also for the establishment of physical activity-friendly environments, societies, and systems. This includes social conditions, such as social support and social norms, spatial

conditions, such as better access to physical activity spaces and opportunities and the provision of corresponding resources, but also policy frameworks, such as the development of multisectoral partnerships and the corresponding support by government and legislation.

The integration of socially disadvantaged population groups in particular represents a major challenge in the context of health and physical activity promotion. This primarily concerns behavior-related measures (Kuntz et al., 2018). Measures aimed at changing structures, on the other hand, are considered to be of high importance with regard to the integration of socially disadvantaged population groups as they often provide easier accessibility and lower participation barriers (Rütten, 2017; Rütten & Pfeifer, 2016). Structural and environmental promotion of sport and physical activity can thus also contribute to equal health opportunities.

Despite the proclaimed importance of interventions aimed at changing structures, the evidence base on these approaches is still highly clear compared to individual behavioral interventions. The dissertation aims to address this research gap by taking a step back and providing deeper insights into the social and environmental structures of sport and physical activity. The findings provide a basis for the development of systematic and sustainable strategies to the promotion of sport and physical activity.

Theoretical background

In line with the intervention mapping approach from Bartholomew Eldredge et al. (2016), the theoretical framework guiding this work is based on a “problem-driven perspective” (p. 8). Accordingly, in order to be able to explain, solve, or prevent problems in the field of health promotion, it often seems more reasonable to make use of different theoretical perspectives rather than trying to develop solutions based on a single theoretical approach. This does not necessarily include only scientific evidence but also opinions and experiences of community members and experts, who have context-specific knowledge. That is why the dissertation is based on a multitheoretical approach, which will be explained in more detail below.

The focus of this work lies on the structures of physical activity promotion. The concept of structure is of central importance in sociological research. The basic assumption is that people can act within and change societal structures but are also significantly influenced by them. According to Huinink and Schröder (2019), societal structures are

relatively stable phenomena that usually undergo only slow changes. They regulate and order the interactions of people in a society and serve as an orientation for their expectations and actions. By defining opportunities and restrictions for people's actions, structures control societal processes.

Sociologists differ in their understanding of the concept of societal structures. In this work, we refer to the three dimensions of societal structures according to Esser (1999). However, there are many cross connections to other sociological approaches. Esser (1999) distinguishes between the superstructure, the institutional and social structure, and the infrastructure. The superstructure is the top level in Esser's model and refers to ideological, cultural, and normative aspects of society. This includes collectively shared knowledge, overarching values and worldviews, religion, educational systems, political ideologies, and other cultural influences in which the constitution of a society is legitimized. The term derives from Marxist theory, according to which the superstructure includes, for example, culture, institutions, rituals, roles, and the state, and is superior to the base, i.e., the mode of production (Marx, 1980). The institutional structure (Esser, 1999) contains the sum of specific social and cultural norms, rules, and values that determine the actions of the actors of a society and divide them into legitimate and non-legitimate behavior. It is represented in societal subsystems, such as the economy and politics, in the interest structure, which reflects the distribution of cultural aims, the control structure, which emerges from the respective societal governance system, and the corporative structure, consisting of, for example, associations and parties. References to the institutional structure can also be found in Weber (2009), who refers to an "ethnic" commonality belief that is part of every society and contributes to an overarching sense of community. Esser (1999) further divides the social structure into the relationship structure and the structures of social inequality. The relationship structure represents the sum of the permanently established relationships between the members of a society, also referred to as social networks. This approach can be traced back to Simmel (1987, 1989), who assumed that everything is connected to everything else and that the mutual relationships between individuals create social structures that exhibit a certain coherence and durability. The structures of social inequality can be seen as an indicator for the distribution of social resources and socially relevant characteristics (e.g., socioeconomic status, gender, migration background, ethnic affiliation, lifestyle). In sociological research, the social structure is often understood to mean either

the distribution of social statistical characteristics in the form of horizontal and vertical inequalities in a population (Geißler, 2012) or the structure of social relationships alone (Bahrdt, 2014). Following Esser (1999) and Huinink & Schröder (2019), we consider the social structure as a two-dimensional construct consisting of the relationship structure *and* the structures of social inequality. In addition to the superstructure and the institutional and social structure, Esser (1999) also mentions the infrastructure which represents the material basis of a society. It includes buildings, roads, railways, and energy networks, but also the knowledge of technical capabilities, climatic and geographical conditions as well as the human capital of a society. Löw (2016) and Lefebvre (1991) do not see the infrastructure of a society as objectively given but as socially constructed. Accordingly, spaces do not exist independently of the members of a society, but are the product of their actions and relationships with each other. This work is oriented towards a combination of both approaches. The infrastructure is considered as the material basis of society but we also assume that the perception of spatial conditions is shaped by the social environment. Three of the structures described have been recently applied to the field of physical activity promotion (Wäsche, 2022): The infrastructure, the institutional structure, and the social structure. The superstructure is to be understood as a superior structure, which influences the mentioned structures but only plays a subordinate role in the following work.

A basic theoretical premise on which the dissertation is based is that human behavior takes place in complex social ecological systems, as individuals live, learn, and work in many different multi-layered environments and settings. Individual physical activity behavior is therefore determined by existing structures at multiple levels (interpersonal, organizational, community, and societal) while each lower level is embedded in higher levels (Kok et al., 2008; Sallis et al., 2006). Thus, in order to change physical activity behavior, the structures relevant to it must be addressed. However, it is important to note that social ecological models account for multiple interactions between individual actions and structural conditions. Thus, it is assumed that individual actions also influence the environment and that health-promoting behaviors are the result of the immediate and lifelong confrontation with the reciprocal influences of the community and societal environment on the individual actor (Glass & McAtee, 2006; Simons-Morton, 2013).

The social ecological model is consistent with the concept of "systems thinking" (Kok et al., 2008; McLeroy, 2006; Trochim et al., 2006). Here, the different levels of the environment are seen as interrelated social systems. Behaviors, actors, and settings are part of the system, which has an impact on or is influenced by a particular problem. Viewing the system as a whole can help identify the needs and strengths of a population, understand problems and their causes more quickly, develop solutions, and build coalitions of relevant actors to address problems effectively (Bartholomew Eldredge et al., 2016).

The setting approach as part of the Ottawa Charter (World Health Organization Regional Office for Europe, 1986) has its roots in the social ecological model and the concept of "systems thinking". It assumes that a basic knowledge of processes, conditions, and structures of a specific setting is a prerequisite for health promotion to be successful (Dooris, 2009, 2013; Green et al., 2000; Paton et al., 2005). Settings, such as the workplace, the school, the community, or the family environment, are understood as delimited social contexts that have an influence on the health of the people who are affiliated to them. For this reason, they serve as a starting point for health-promoting interventions and measures that aim to influence not only individual behavior but above all the system and the conditions of the setting itself. The primary focus of this work is on community-based approaches, as the immediate environment in which people live, learn, work, commute, and exercise is a key setting where physical activity promotion should be initiated (Rütten & Pfeifer, 2016; Sallis et al., 2006). For example, Bauman et al. (2012) found that the existence of organized sports structures and physical activity opportunities in a person's immediate environment has a major impact on his or her physical activity behavior. While the focus on specific settings is a key to successful physical activity promotion, it is not only the immediate environment that needs to be considered but also actors on different administrative levels (Butterfoss et al., 2008): Actors at higher levels can initiate different processes, such as exercising decision-making power and passing laws, than actors at a lower level, who mostly interact directly with the target group.

One of the focal points of this doctoral thesis is the analysis of relationship structures in the context of sport and physical activity promotion. An important assumption is that one actor or sector alone is not able to address complex societal challenges such as the promotion of physical activity (Butterfoss et al., 1996; Provan et al., 2005). It

requires intersectoral collaboration between relevant actors from different sectors of society to bring together different perspectives, expertise, competencies, and resources (Bevc et al., 2015a; Lasker & Weiss, 2003; Mays & Scutchfield, 2010; Varda et al., 2008). Thereby, ideas and solutions can be developed jointly and organizational capacity can be built to address public health problems more efficiently and effectively (Provan et al., 2003; Provan et al., 2005; Valente et al., 2015). To analyze intersectoral cooperation in this work, we used principles of social network analysis. Network research is based on a relational perspective, which means that phenomena of interest are explained by the underlying structures. It is assumed that individual actors do not act in isolation from each other but in mutual dependence. Thus, the unit of investigation is not individual social actors but their relationship to each other and their embedding in larger social structures (Borgatti et al., 2013; Emirbayer, 1997; Hennig et al., 2012; Kadushin, 2012).

The following work is based on the theoretical concepts described above, whereby depending on the specific part of the dissertation different approaches are more central than others.

Aims and structure

The overall aim of this dissertation is to analyze social and environmental structures of sport and physical activity. The findings provide a basis for the development of systematic and sustainable approaches to physical activity promotion. This is a cumulative doctoral thesis consisting of three studies which resulted in four scientific papers. The structure of this work is displayed in Figure 1.

Different methodological approaches were used in each study, whereby in each case the chosen method was determined by the respective research question. Thus, this dissertation comprises a qualitative methodological approach (Paper I) as well as descriptive and stochastic methods of social network analysis (Paper II and III), and a quantitative methodological approach (Paper IV).

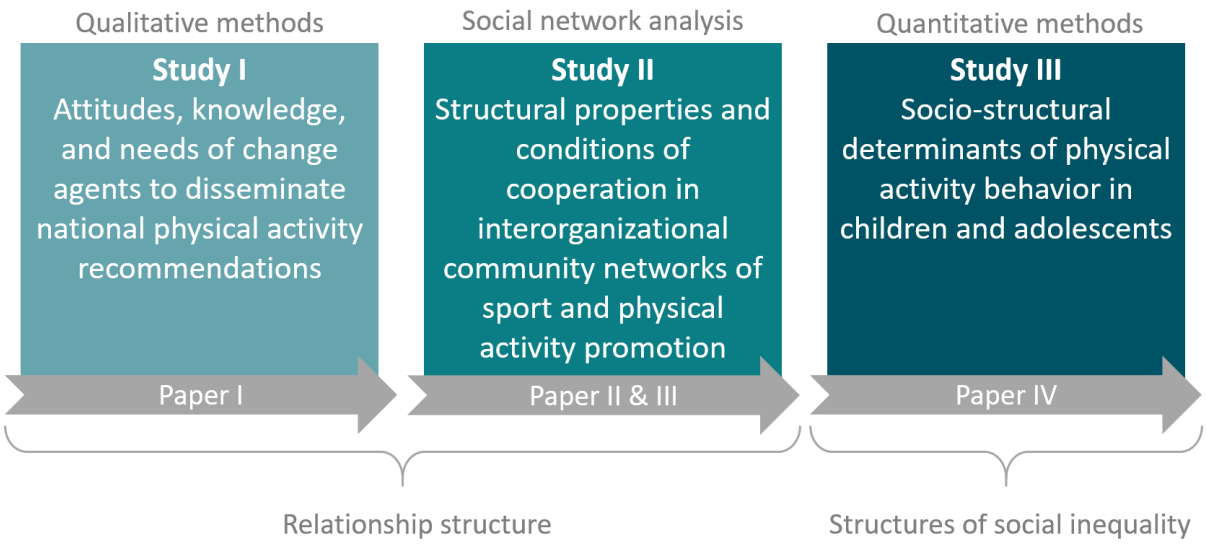


Figure 1: Overview of the four papers included in the doctoral thesis

With reference to Esser (1999), the infrastructure, institutional structure, and social structures, i.e. the relationship structure and the structures of social inequality, are given special consideration in this work. Depending on the specific part of the doctoral thesis, however, the emphasis is put on different structures. While the first two studies primarily address the relationship structure, the focus of the third study lies on the structures of social inequality. In all three studies, the main question is which structural conditions must be fulfilled for physical activity and physical activity promotion to take place. In order to shed light on the central topic of this doctoral thesis from various perspectives, the individual studies are located at different levels. While Study I deals with the topic of physical activity promotion from a national perspective, Study II looks at the community level and Study III addresses the individual level. The aims and main results of the individual studies are described in more detail below.

Study I: Attitudes, knowledge, and needs of change agents to disseminate national physical activity recommendations

To counteract the lack of physical activity in Germany, the National Recommendations for Physical Activity and Physical Activity Promotion were published in 2016 (Rütten & Pfeifer, 2016). They are aimed at professional actors and organizations in the context of sport and physical activity promotion and provide evidence-based and target group-specific guidelines and measures. However, to date, it lacks an efficient strategy to disseminate and implement physical activity recommendations across populations.

Environmental and social conditions are often under the control of change agents of sport and physical activity promotion, such as teachers, politicians, community departments, or mass media. Change agents are decision makers (Rütten et al., 2018), role models (Babey et al., 2016) and/or knowledge brokers (Ballew et al., 2010) who can disseminate target group specific knowledge regarding physical activity on the one hand, and have a significant influence on changing structures on the other hand. Therefore, they are key to implementing national physical activity recommendations across populations (Wäsche et al., 2018). A first important step is to identify the relevant change agents. This was done in the SAMBA study, which was able to identify not only relevant actors but also current and potential change agents of sport and physical activity promotion (Wäsche et al., 2018). Following a social ecological approach (Sallis et al., 2006), change agents act on a national, state, or community level in different areas of society (e.g., politics & administration, sport, health, education & research) and are in direct or indirect contact with a specific target group. As experts for their respective setting, they can draw attention to specific real-world challenges so that measures to promote sport and physical activity are adapted to local conditions (Davis et al., 2017; Piercy et al., 2015). With regard to dissemination strategies for physical activity recommendations, change agents of sport and physical activity promotion received little attention in previous studies. These often focused exclusively on the health sector (Brownson et al., 2007) or individual settings (Cooper et al., 2016). However, especially in the case of major public health challenges, it is important to involve diverse sectors, as one sector alone is rarely able to solve such complex problems (Bevc et al., 2015b; van Rinsum et al., 2017). To ensure effective involvement of change agents from different sectors of society, it is necessary to gain a deeper understanding of their situation and context. The first publication of the doctoral thesis (published: Wolbring et al., 2021) therefore addresses the following questions:

a) What are the attitudes and knowledge of change agents regarding physical activity and physical activity promotion?

(b) What are the needs and requirements of change agents regarding the implementation of physical activity recommendations in their specific setting?

The aim is to identify the conditions that have to be fulfilled from the change agents' point of view so that national physical activity recommendations can be implemented in practice.

We conducted qualitative expert interviews with change agents covering various sectors of society and different administrative levels. Nine themes were identified covering the change agents' needs for the implementation of physical activity recommendations: strengthening of political will and cooperation, availability of public space for physical activity, change in awareness and health education, professional qualification, financial incentives, development of physical activity-promoting programs and structures, provision of resources, bridging the theory–practice gap, and knowledge of physical activity recommendations. Based on diffusion of innovations theory (Rogers, 2003), we discussed that these needs may vary depending on the stage the particular change agents have reached in the innovation decision process. Some change agents need basic information on physical activity and physical activity promotion while others need financial resources to proceed with the implementation of physical activity recommendations in their setting. Based on the findings, recommendations for action were developed on how a national dissemination strategy of physical activity recommendations could be designed involving relevant change agents.

Study II: Structural properties and conditions of cooperation in interorganizational community networks of sport and physical activity promotion

To disseminate and implement national physical activity recommendations, the involvement of relevant change agents is not sufficient. In addition, systematic and intersectoral cooperation and networking is needed (Wäsche et al., 2018; World Health Organization, 2018). The basic idea is that population-related health problems, such as physical inactivity, are very complex and multifaceted. However, public resources to address such challenges are scarce. Cooperation of change agents representing public and private organizations from different sectors is therefore essential. Together, they can combine different core competencies and resources, create synergy effects and work more effectively on solutions involving different perspectives. In the area of public health, organizational networks in particular are considered one of the most practice-oriented approaches to promote population health (Bevc et al., 2015b; Provan & Milward, 2001). The community, as the place where living, learning, and working

mainly take place, represents a key setting in this regard (Sallis et al., 2006). Specifically, in relation to community sport and physical activity promotion, the formation of networks has been shown to help increase the adoption, implementation, and maintenance of public health interventions and policies (Muellmann et al., 2017).

Since network analysis is a relatively new approach in sport and physical activity promotion, there are only a few studies that analyze the nature of interorganizational physical activity promotion networks using descriptive methods (Loitz et al., 2017; McCullough et al., 2016). Even more rarely, stochastic methods are used to uncover the mechanisms and conditions of network formation (Meisel et al., 2014; Parra et al., 2011). However, these insights can help change agents to build cooperations and initiate networks, which is essential for a systematic and sustainable promotion of sport and physical activity. The second part of the dissertation therefore addresses the following question:

> *What are (a) structural characteristics and (b) conditions of cooperation in socio-spatial networks of physical activity promotion?*

By analyzing local socio-spatial networks of physical activity promotion, we aim to gain insights into the development and nature of these networks. In the second publication of this work (published: Wäsche*, Wolbring* et al. 2021), we analyzed an interorganizational cooperation network of sport-providing and -coordinating organizations at the community level by means of quantitative descriptive procedures of network analysis as well as stochastic analyses of network modeling. In the third publication (published: Wolbring et al., 2022), the network analyzed in the first publication was compared with another one with regard to structural properties and conditions of cooperative tie formation to identify superordinate mechanisms.

Similar structures and conditions of cooperation were found in the networks. They were characterized by a low density and moderate centralization. The results of the stochastic analyses also showed that fewer relationships were realized than would have been expected by chance. In each case, the actors with the highest number of relationships were the sports-administrating organizations, which thus assume a central role regarding the management of these networks. Also, cooperation often took place in triangular constellations characterized by mutual exchange and trust. As far as attributive effects

are concerned, there was a heterophily effect: Organizations from different sectors co-operated with each other more often than organizations from the same sector.

Based on our results, we derived measures and recommendations on how to develop the networks and manage them as efficiently as possible. The insights gained can help change agents to initiate networks purposefully and leverage them to promote sport and physical activity in their setting.

Study III: Socio-structural determinants of physical activity behavior in children and adolescents

Since children and adolescents in particular are not sufficiently active (Jekauc et al., 2012; Schmidt et al., 2020), measures and interventions to promote physical activity behavior specifically among this target group are of particular importance. To implement national physical activity recommendations among children and adolescents, it is important to find out which factors in particular promote but also prevent sport and physical activity among young age groups (Sallis et al., 2000; Schmidt et al., 2019). In light of the fact that structural approaches to physical activity promotion, in contrast to individual behavioral interventions, can primarily reach socially disadvantaged population groups (Rütten, 2017; Rütten & Pfeifer, 2016), a more in-depth consideration of socio-structural mechanisms appears to be useful in addition to individual determinants. Recent studies show that children's and adolescents' physical activity is influenced by socioeconomic inequalities (Biddle et al., 2011), social support from family and friends (Mendonça et al., 2014; Prochnow et al., 2023), and a physical environment conducive to physical activity (Sterdt et al., 2014). However, the direct and indirect influences of these socio-structural determinants and the interactions among them in relation to the physical activity behavior of children and adolescents have not been investigated so far. The fourth publication of the doctoral thesis (Wolbring et al., submitted) therefore addresses the following question:

What influence does parental socioeconomic status, social support from family and peers, and the physical environment have on the physical activity behavior of children and adolescents?

The three socio-structural determinants examined represent the societal structures according to Esser (1999) introduced earlier. The main focus was on the structures of social inequality represented by parental socioeconomic status. The aim of the study

is to investigate the influence of structural conditions on physical activity behavior, taking into account social inequalities. We assume that socioeconomic status has a direct effect but also an indirect effect on physical activity behavior via social support, as an indicator of the relationship structure, and via the physical environment, as an indicator of the infrastructure. Contrary to previous research, which mainly measures physical activity behavior through self-report methods, we use device-based measurement methods, which can more reliably depict actual physical activity (Burchartz et al., 2020; Slootmaker et al., 2009).

To investigate the research question, we use cross-sectional data from the second wave (2014-2017) of the Motorik-Modul Study (MoMo) (Woll et al., 2017). The sample included children and adolescents aged 6-17 years.

Among children, only social support had a direct effect on physical activity behavior. In addition, social support influenced the perceived physical environment. Socioeconomic status did not have a direct but an indirect effect on physical activity via social support. For adolescents, all of the socio-structural determinants had a direct effect on physical activity behavior. Nevertheless, social support had the strongest direct influence on physical activity behavior and also indirectly influenced physical activity behavior via the physical environment. Socioeconomic status had a direct and indirect effect on physical activity via the physical environment and social support.

Knowledge about the interaction of these factors enables the planning of effective and sustainable interventions on a socio-structural level to promote the physical activity behavior of children and adolescents with a special focus on socially disadvantaged population groups.

Philosophy of science and research paradigms

In the following, the scientific theoretical positions that form the basis of the procedure for gaining knowledge in this work will be discussed. In combining different theories and methods, we chose a pragmatic approach, according to which the content of a theory or concept is measured by its practical application and consequences (Rorty, 1981). Our goal was to gain insights into a social problem such as physical inactivity, combining objective and subjective perspectives in order to develop useful solutions oriented to the everyday lives of the people concerned. In the first study, we chose a qualitative methodological approach, based on a social constructivist and interpretive

paradigm (Berger & Luckmann, 1966). Thus, in this study, we adopted the position that reality does not exist objectively but is socially constructed. Consequently, the findings were interpreted and classified by taking into account the lifeworld and self-understandings of the interviewees. To keep with the pragmatic approach, however, we have placed the results in the overarching context of this work and derived generic recommendations for action. The qualitative part of this thesis was complemented by network-analytical and quantitative investigations, which were rather based on a natural scientific paradigm. Hence, we adopted the position of critical rationalism (Popper, 2002) in the second and third study. According to this paradigm, scientific statements cannot be verified by observations, but only falsified. Thus, every scientific theory is only provisionally confirmed until it is disproved.

In this work, the structures of physical activity promotion were examined from different scientific theoretical perspectives, allowing us to shed light on a variety of facets regarding the problem of interest. Due to the pragmatic approach, however, many cross-connections can be identified at the same time. Overall and in distinction to the idea of action research, the methodical procedure and the gained knowledge in this work are subject to the principles of neutrality and freedom from value judgement.

References

Babey, S. H., Wolstein, J., & Diamant, A. L. (2016). Adolescent physical activity: Role of school support, role models, and social participation in racial and income disparities. *Environment and Behavior*, *48*(1), 172–191. https://doi.org/10.1177/0013916515609086

Bahrdt, H. P. (2014). *Schlüsselbegriffe der Soziologie: Eine Einführung mit Lehrbeispielen* (10th ed.). Beck.

Ballew, P., Brownson, R. C., Haire-Joshu, D., Heath, G. W., & Kreuter, M. W. (2010). Dissemination of effective physical activity interventions: Are we applying the evidence? *Health Education Research*, *25*(2), 185–198. https://doi.org/10.1093/her/cyq003

Bartholomew Eldredge, L. K., Markham, C. M., Ruiter, R. A. C., Fernández, M. E., Kok, G., & Parcel, G. S. (2016). *Planning health promotion programs: An intervention mapping approach* (4th ed.). Jossey-Bass.

Bauman, A. E., Reis, R. S., Sallis, J. F., Wells, J. C., Loos, R. J. F., & Martin, B. W. (2012). Correlates of physical activity: Why are some people physically active and others not? *The Lancet*, *380*(9838), 258–271. https://doi.org/10.1016/S0140-6736(12)60735-1

Berger, P. L., & Luckmann, T. (1966). *The social construction of reality: A treatise in the sociology of knowledge*. Anchor Books.

Bevc, C. A., Retrum, J. H., & Varda, D. M. (2015a). New perspectives on the "silo effect": Initial comparisons of network structures across public health collaboratives. *American Journal of Public Health*, *105*(Suppl. 2), 230-235. https://doi.org/10.2105/AJPH.2014.302256

Bevc, C. A., Retrum, J. H., & Varda, D. M. (2015b). Patterns in PARTNERing across public health collaboratives. *International Journal of Environmental Research and Public Health*, *12*(10), 12412–12425. https://doi.org/10.3390/ijerph121012412

Biddle, S. J., Atkin, A. J., Cavill, N., & Foster, C. (2011). Correlates of physical activity in youth: A review of quantitative systematic reviews. *International Review of Sport and Exercise Psychology*, *4*(1), 25–49. https://doi.org/10.1080/1750984X.2010.548528

Borgatti, S. P., Everett, M. G., & Johnson, J. C. (2013). *Analyzing social networks*. SAGE.

Bornstein, D. B., Carnoske, C., Tabak, R., Maddock, J., Hooker, S. P., & Evenson, K. R. (2013). Factors related to partner involvement in development of the US national physical activity plan, *19*(3, Suppl.), S8-S16. https://doi.org/10.1097/PHH.0b013e318284047d

Brownson, R. C., Ballew, P., Brown, K. L., Elliott, M. B., Haire-Joshu, D., Heath, G. W., & Kreuter, M. W. (2007). The effect of disseminating evidence-based interventions that promote physical activity to health departments. *American Journal of Public Health*, *97*(10), 1900–1907. https://doi.org/10.2105/AJPH.2006.090399

Burchartz, A., Anedda, B., Auerswald, T., Giurgiu, M., Hill, H., Ketelhut, S., Kolb, S., Mall, C., Manz, K., Nigg, C. R., Reichert, M., Sprengeler, O., Wunsch, K., & Matthews, C. E. (2020). Assessing physical behavior through accelerometry – State of the science, best practices and future directions. *Psychology of Sport*

and Exercise, *49*, Article 101703. https://doi.org/10.1016/j.psychsport.2020.101703

Butterfoss, F. D., Goodman, R. M., & Wandersman, A. (1996). Community coalitions for prevention and health promotion: Factors predicting satisfaction, participation, and planning. *Health Education Quarterly*, *23*(1), 65–79. https://doi.org/10.1177/109019819602300105

Butterfoss, F. D., Kegler, M. C., & Francisco, V. T. (2008). Mobilizing organizations for health promotion: Theories of organizational change. In K. Glanz, B. K. Rimer, & K. Viswanath (Eds.), *Health behaviour and health education: Theory, research and practice* (4th ed., pp. 335–361). John Wiley.

Cooper, K. H., Greenberg, J. D., Castelli, D. M., Barton, M., Martin, S. B., & Morrow, J.R., Jr. (2016). Implementing policies to enhance physical education and physical activity in schools. *Research Quarterly for Exercise and Sport*, *87*(2), 133–140. https://doi.org/10.1080/02701367.2016.1164009

Davis, S. M., Cruz, T. H., & Kozoll, R. L. (2017). Research to practice: Implementing physical activity recommendations. *American Journal of Preventive Medicine*, *52*(3.3, Suppl.), S300-S303. https://doi.org/10.1016/j.amepre.2016.09.028

Ding, D., Lawson, K. D., Kolbe-Alexander, T. L., Finkelstein, E. A., Katzmarzyk, P. T., van Mechelen, W., & Pratt, M. (2016). The economic burden of physical inactivity: A global analysis of major non-communicable diseases. *The Lancet*, *388*(10051), 1311–1324. https://doi.org/10.1016/S0140-6736(16)30383-X

Dooris, M. (2009). Holistic and sustainable health improvement: The contribution of the settings-based approach to health promotion. *Perspectives in Public Health*, *129*(1), 29–36. https://doi.org/10.1177/1757913908098881

Dooris, M. (2013). Expert voices for change: Bridging the silos-towards healthy and sustainable settings for the 21st century. *Health & Place*, *20*, 39–50. https://doi.org/10.1016/j.healthplace.2012.11.009

Emirbayer, M. (1997). Manifesto for a relational sociology. *American Journal of Sociology*, *103*(2), 281–317. https://doi.org/10.1086/231209

Esser, H. (1999). *Soziologie: Allgemeine Grundlagen* (3rd ed.). Campus Verlag.

Frieden, T. R., Dietz, W., & Collins, J. (2010). Reducing childhood obesity through policy change: Acting now to prevent obesity. *Health Affairs*, *29*(3), 357–363. https://doi.org/10.1377/hlthaff.2010.0039

Geißler, R. (2012). *Die Sozialstruktur Deutschlands: Zur gesellschaftlichen Entwicklung mit einer Bilanz zur Vereinigung* (6th ed.). Springer. https://doi.org/10.1007/978-3-531-19151-5

Glass, T. A., & McAtee, M. J. (2006). Behavioral science at the crossroads in public health: Extending horizons, envisioning the future. *Social Science & Medicine*, *62*(7), 1650–1671. https://doi.org/10.1016/j.socscimed.2005.08.044

Green, L. W., Poland, B. D., & Rootman, I. (2000). The settings approach to health promotion. In B. D. Poland, L. W. Green, & I. Rootman (Eds.), *Settings for health promotion: Linking theory and practice* (pp. 1–43). SAGE Publications.

Guthold, R., Stevens, G. A., Riley, L. M., & Bull, F. C. (2018). Worldwide trends in insufficient physical activity from 2001 to 2016: A pooled analysis of 358 population-based surveys with 1·9 million participants. *The Lancet Global Health*, *6*(10), e1077-e1086. https://doi.org/10.1016/S2214-109X(18)30357-7

Hamer, M., O'Donovan, G., & Murphy, M. (2017). Physical inactivity and the economic and health burdens due to cardiovascular disease: Exercise as medicine. In J. Xiao (Ed.), *Exercise for cardiovascular disease prevention and treatment: From molecular to clinical, Part 1* (pp. 3–18). Springer Singapore. https://doi.org/10.1007/978-981-10-4307-9_1

Heath, G. W., Parra, D. C., Sarmiento, O. L., Andersen, L. B., Owen, N., Goenka, S., Montes, F., & Brownson, R. C. (2012). Evidence-based intervention in physical activity: Lessons from around the world. *The Lancet*, *380*(9838), 272–281. https://doi.org/10.1016/S0140-6736(12)60816-2

Hennig, M., Brandes, U., Pfeffer, J., & Mergel, I. (2012). *Studying social networks: A guide to empirical research* (1st ed.). Campus Verlag. http://gbv.eblib.com/patron/FullRecord.aspx?p=1026766

Huinink, J., & Schröder, T. (2019). *Sozialstruktur Deutschlands* (3rd ed.). UVK Verlag. https://doi.org/10.36198/9783838552019

Jekauc, D., Reimers, A. K., Wagner, M., & Woll, A. (2012). Prevalence and socio-demographic correlates of the compliance with the physical activity guidelines in children and adolescents in Germany. *BMC Public Health*, *12*, Article 714. https://doi.org/10.1186/1471-2458-12-714

Kadushin, C. (2012). *Understanding social networks: Concepts, theories, and findings*. Oxford University Press. http://lib.myilibrary.com/detail.asp?ID=342698

Kok, G., Gottlieb, N. H., Commers, M., & Smerecnik, C. (2008). The ecological approach in health promotion programs: A decade later. *American Journal of Health Promotion*, *22*(6), 437–442. https://doi.org/10.4278/ajhp.22.6.437

Kuntz, B., Waldhauer, J., Zeiher, J., Finger, J. D., & Lampert, T. (2018). Soziale Unterschiede im Gesundheitsverhalten von Kindern und Jugendlichen in Deutschland – Querschnittergebnisse aus KiGGS Welle 2. *Journal of Health Monitoring*, *3*(2), 45–63. https://doi.org/10.17886/RKI-GBE-2018-067

Lasker, R. D., & Weiss, E. S. (2003). Creating partnership synergy: The critical role of community stakeholders. *Journal of Health and Human Services Administration*, *26*(1), 119–139. https://www.jstor.org/stable/41288031

Lefebvre, H. (1991). *The production of space* (1st ed.). Wiley-Blackwell.

Loitz, C. C., Stearns, J. A., Fraser, S. N., Storey, K., & Spence, J. C. (2017). Network analysis of inter-organizational relationships and policy use among active living organizations in Alberta, Canada. *BMC Public Health*, *17*(1), Article 649. https://doi.org/10.1186/s12889-017-4661-5

Löw, M. (2016). *The sociology of space: Materiality, social structures, and action* (1st ed.). Palgrave Macmillan. https://doi.org/10.1057/978-1-349-69568-3

Marx, K. (1980). Zur Kritik der politischen Ökonomie. Urtext. In L. Miskewitsch, I. Antonowa, & L. Wassina (Eds.), *Gesamtausgabe MEGA. BAND 2 Karl Marx: Ökonomische Manuskripte und Schriften, 1858-1861* (pp. 17–94). De Gruyter Akademie Forschung. https://doi.org/10.1515/9783050076317-004

Mays, G. P., & Scutchfield, F. D. (2010). Improving public health system performance through multiorganizational partnerships. *Preventing Chronic Disease*, *7*(6), Article 116.

McCullough, J. M., Eisen-Cohen, E., & Salas, S. B. (2016). Partnership capacity for community health improvement plan implementation: Findings from a social network analysis. *BMC Public Health*, *16*(1), Article 566. https://doi.org/10.1186/s12889-016-3194-7

McLeroy, K. (2006). Thinking of Systems. *American Journal of Public Health*, *96*(3), 402. https://doi.org/10.2105/AJPH.2005.084459

Meisel, J. D., Sarmiento, O. L., Montes, F., Martinez, E. O., Lemoine, P. D., Valdivia, J. A., Brownson, R. C., & Zarama, R. (2014). Network analysis of Bogotá's Ciclovía Recreativa, a self-organized multisectorial community program to

promote physical activity in a middle-income country. *American Journal of Health Promotion*, *28*(5), e127-e136. https://doi.org/10.4278/ajhp.120912-QUAN-443

Mendonça, G., Cheng, L. A., Mélo, E. N., & de Farias Júnior, J. C. (2014). Physical activity and social support in adolescents: A systematic review. *Health Education Research*, *29*(5), 822–839. https://doi.org/10.1093/her/cyu017

Muellmann, S., Steenbock, B., Cocker, K. de, Craemer, M. de, Hayes, C., O'Shea, M. P., Horodyska, K., Bell, J., Luszczynska, A., Roos, G., Langøien, L. J., Rugseth, G., Terragni, L., Bourdeaudhuij, I. de, Brug, J., & Pischke, C. R. (2017). Views of policy makers and health promotion professionals on factors facilitating implementation and maintenance of interventions and policies promoting physical activity and healthy eating: Results of the DEDIPAC project. *BMC Public Health*, *17*(1), Article 932. https://doi.org/10.1186/s12889-017-4929-9

Parra, D. C., Dauti, M., Harris, J. K., Reyes, L., Malta, D. C., Brownson, R. C., Quintero, M. A., & Pratt, M. (2011). How does network structure affect partnerships for promoting physical activity? Evidence from Brazil and Colombia. *Social Science & Medicine*, *73*(9), 1365–1370. https://doi.org/10.1016/j.socscimed.2011.08.020

Paton, K., Sengupta, S., & Hassan, L. (2005). Settings, systems and organization development: The Healthy Living and Working Model. *Health Promotion International*, *20*(1), 81–89. https://doi.org/10.1093/heapro/dah510

Piercy, K. L., Dorn, J. M., Fulton, J. E., Janz, K. F., Lee, S. M., McKinnon, R. A., Pate, R. R., Pfeiffer, K. A., Young, D. R., Troiano, R. P., & Lavizzo-Mourey, R. (2015). Opportunities for public health to increase physical activity among youths. *American Journal of Public Health*, *105*(3), 421–426. https://doi.org/10.2105/AJPH.2014.302325

Popper, K. R. (2002). *The logic of scientific discovery* (2nd ed.). Routledge.

Prochnow, T., Curran, L. S., Amo, C., & Patterson, M. S. (2023). Bridging the built and social environments: A systematic review of studies investigating influences on physical activity. *Journal of Physical Activity & Health*, *20*(5), 438–459. https://doi.org/10.1123/jpah.2022-0403

Provan, K. G., & Milward, H. B. (2001). Do networks really work? A framework for evaluating public-sector organizational networks. *Public Administration Review*, *61*(4), 414–423. http://www.jstor.org/stable/977503

Provan, K. G., Nakama, L., Veazie, M. A., Teufel-Shone, N. I., & Huddleston, C. (2003). Building community capacity around chronic disease services through a collaborative interorganizational network. *Health Education & Behavior*, *30*(6), 646–662. https://doi.org/10.1177/1090198103255366

Provan, K. G., Veazie, M. A., Staten, L. K., & Teufel-Shone, N. I. (2005). The use of network analysis to strengthen community partnerships. *Public Administration Review*, *65*(5), 603–613. https://doi.org/10.1111/j.1540-6210.2005.00487.x

Reiner, M., Niermann, C., Jekauc, D., & Woll, A. (2013). Long-term health benefits of physical activity - A systematic review of longitudinal studies. *BMC Public Health*, *13*(1), Article 813. https://doi.org/10.1186/1471-2458-13-813

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press. http://www.loc.gov/catdir/bios/simon052/2003049022.html

Rorty, R. (1981). *Philosophy and the mirror of nature* (1st ed.). Princeton University Press.

Rütten, A. (2017). Sportwissenschaft, Bewegungsförderung und Public Health. *German Journal of Exercise and Sport Research*, *47*(1), 72–81. https://doi.org/10.1007/s12662-016-0434-z

Rütten, A., Abu-Omar, K., Messing, S., Weege, M., Pfeifer, K., Geidl, W., & Hartung, V. (2018). How can the impact of national recommendations for physical activity be increased? Experiences from Germany. *Health Research Policy and Systems*, *16*, Article 121. https://doi.org/10.1186/s12961-018-0396-8

Rütten, A., & Pfeifer, K. (Eds.). (2016). *Nationale Empfehlungen für Bewegung und Bewegungsförderung*. FAU Erlangen-Nürnberg.

Sallis, J. F., Cervero, R. B., Ascher, W., Henderson, K. A., Kraft, M. K., & Kerr, J. (2006). An ecological approach to creating active living communities. *Annual Review of Public Health*, *27*, 297–322. https://doi.org/10.1146/annurev.publhealth.27.021405.102100

Sallis, J. F., Linton, L. S., Kraft, M. K., Cutter, C. L., Kerr, J., Weitzel, J., Wilson, A. L., Spoon, C., Harrison, I. D., Cervero, R., Patrick, K., Schmid, T. L., & Pratt, M. (2009). The Active Living Research program: Six years of grantmaking.

American Journal of Preventive Medicine, *36*(2, Suppl.), S10-S21. https://doi.org/10.1016/j.amepre.2008.10.007

Sallis, J. F., Prochaska, J. J., & Taylor, W. C. (2000). A review of correlates of physical activity of children and adolescents. *Medicine and Science in Sports and Exercise*, *32*(5), 963–975. https://doi.org/10.1097/00005768-200005000-00014

Schmidt, S. C. E., Anedda, B., Burchartz, A., Eichsteller, A., Kolb, S., Nigg, C., Niessner, C., Oriwol, D., Worth, A., & Woll, A. (2020). Physical activity and screen time of children and adolescents before and during the COVID-19 lockdown in Germany: A natural experiment. *Scientific Reports*, *10*(1), Article 21780. https://doi.org/10.1038/s41598-020-78438-4

Schmidt, S. C. E., Schneider, J., Reimers, A. K., Niessner, C., & Woll, A. (2019). Exploratory determined correlates of physical activity in children and adolescents: The MoMo study. *International Journal of Environmental Research and Public Health*, *16*(3), Article 415. https://doi.org/10.3390/ijerph16030415

Simmel, G. (1987). Der Konflikt der modernen Kultur. In G. Simmel, M. Landmann, & K. C. Köhnke (Eds.), *Das individuelle Gesetz: Philosophische Exkurse* (1st ed., pp. 148–173). Suhrkamp.

Simmel, G. (1989). *Gesamtausgabe 2: Aufsätze 1887 - 1890. Über sociale Differenzierung. Die Probleme der Geschichtsphilosophie (1892)* (2nd ed.). Suhrkamp.

Simons-Morton, B. G. (2013). Health behavior in ecological context. *Health Education & Behavior*, *40*(1), 6–10. https://doi.org/10.1177/1090198112464494

Slootmaker, S. M., Schuit, A. J., Chinapaw, M. J., Seidell, J. C., & van Mechelen, W. (2009). Disagreement in physical activity assessed by accelerometer and self-report in subgroups of age, gender, education and weight status. *The International Journal of Behavioral Nutrition and Physical Activity*, *6*, Article 17. https://doi.org/10.1186/1479-5868-6-17

Sterdt, E., Liersch, S., & Walter, U. (2014). Correlates of physical activity of children and adolescents: A systematic review of reviews. *Health Education Journal*, *73*(1), 72–89. https://doi.org/10.1177/0017896912469578

Trochim, W. M., Cabrera, D. A., Milstein, B., Gallagher, R. S., & Leischow, S. J. (2006). Practical challenges of systems thinking and modeling in public health. *American Journal of Public Health*, *96*(3), 538–546. https://doi.org/10.2105/AJPH.2005.066001

Valente, T. W., Palinkas, L. A., Czaja, S., Chu, K.-H., & Brown, C. H. (2015). Social network analysis for program implementation. *PloS One*, *10*(6), Article e0131712. https://doi.org/10.1371/journal.pone.0131712

van Rinsum, C. E., Gerards, S., Rutten, G. M., van de Goor, I., & Kremers, S. (2017). Health brokers: How can they help deal with the wickedness of public health problems? *BioMed Research International*, *2017*, Article 1979153. https://doi.org/10.1155/2017/1979153

Varda, D. M., Chandra, A., Stern, S. A., & Lurie, N. (2008). Core dimensions of connectivity in public health collaboratives. *Journal of Public Health Management and Practice*, *14*(5), E1-7. https://doi.org/10.1097/01.PHH.0000333889.60517.46

Wäsche, H. (2022). Auf die Beziehungen kommt es an! Die Analyse sozialer Netzwerke in der Sportwissenschaft. *Sport Und Gesellschaft*, *19*(2), 131–162. https://doi.org/10.1515/sug-2022-0015

Wäsche, H., Peters, S., Appelles, L., & Woll, A. (2018). Bewegungsförderung in Deutschland: Akteure, Strukturen und Netzwerkentwicklung. *Bewegungstherapie & Gesundheitssport*, *34*(6), 257–273. https://doi.org/10.1055/a-0739-9857

Wäsche, H., Wolbring, L., & Woll, A. (2021). Physical activity promotion in an urban district: Analyzing the mechanisms of interorganizational cooperation. *PloS One*, *16*(11), Article e0260053. https://doi.org/10.1371/journal.pone.0260053

Weber, M. (2009). *Wirtschaft und Gesellschaft: Grundriss der verstehenden Soziologie* (5th ed.). Mohr Siebeck.

Wolbring, L., Jekauc, D., Hinz, T., Burchartz, A., Kolb, S., Schmidt, S. C. E., Woll, A., & Wäsche, H. (submitted). Socio-structural determinants of physical activity behavior in children and adolescents: The importance of social support. *Social Science & Medicine*.

Wolbring, L., Reimers, A. K., Niessner, C., Demetriou, Y., Schmidt, S. C. E., Woll, A., & Wäsche, H. (2021). How to disseminate national recommendations for physical activity: A qualitative analysis of critical change agents in Germany. *Health Research Policy and Systems*, *19*(1), Article 78. https://doi.org/10.1186/s12961-021-00729-7

Wolbring, L., Schmidt, S. C. E., Niessner, C., Woll, A., & Wäsche, H. (2022). Community networks of sport and physical activity promotion: An analysis of structural

properties and conditions of cooperation. *BMC Public Health*, *22*(1), Article 1966. https://doi.org/10.1186/s12889-022-14383-3

Woll, A., Albrecht, C., & Worth, A. (2017). Motorik-Module (MoMo) – the KiGGS wave 2 module to survey motor performance and physical activity. *Journal of Health Monitoring*, *2*(Suppl. 3), 63–70. https://doi.org/10.17886/RKI-GBE-2017-110

World Health Organization. (2018). *More active people for a healthier world: Global action plan on physical activity 2018-2030*. World Health Organization. https://www.who.int/publications/i/item/9789241514187

World Health Organization. (2020). *WHO guidelines on physical activity and sedentary behaviour*. World Health Organization. https://www.who.int/publications/i/item/9789240015128

World Health Organization. (2022a). *Global status report on physical activity 2022*. World Health Organization. https://www.who.int/teams/health-promotion/physical-activity/global-status-report-on-physical-activity-2022

World Health Organization. (2022b). *Global status report on physical activity 2022: Country profiles*. World Health Organization. https://www.who.int/publications/i/item/9789240064119

World Health Organization Regional Office for Europe. (1986). *Ottawa Charter for Health Promotion*. https://iris.who.int/bitstream/handle/10665/349652/WHO-EURO-1986-4044-43803-61677-eng.pdf

Chapter 2: How to disseminate national recommendations for physical activity

Paper I: How to disseminate national recommendations for physical activity: A qualitative analysis of critical change agents in Germany[1]

Slightly modified version of the published paper

Wolbring, L., Reimers, A. K., Niessner, C., Demetriou, Y., Schmidt, S. C. E., Woll, A., & Wäsche, H. (2021). How to disseminate national recommendations for physical activity: A qualitative analysis of critical change agents in Germany. *Health Research Policy and Systems*, *19*, Article 78. https://doi.org/10.1186/s12961-021-00729-7

Abstract

Background: Physical activity recommendations are reached by only a small part of the population. A common problem is that research findings on public health-related topics such as physical activity promotion are often times not translated into practice. The involvement of relevant stakeholders, such as change agents (role models, decision-makers, and/or knowledge mediators), is a common strategy to implement physical activity recommendations in specific settings, as they have the necessary knowledge of contextual factors. However, dissemination and implementation of physical activity recommendations are often prevented by focusing exclusively on the health sector and by underestimating the individual perceptions and needs of change agents. Therefore, the purpose of this study was to address the problem of how physical activity recommendations can be translated into practice through comprehensive consideration of the situation and context of change agents from various sectors of society at different administrative levels. This allows for deriving recommendations for action on how a national dissemination strategy of physical activity recommendations should be designed.

Methods: Qualitative expert interviews were conducted with change agents from different sectors of society and administrative levels in Germany (*N* = 21). Case selection

[1] Due to journal requirements, this article has been published in British English. Therefore, this article is not written in American English like the rest of this dissertation.

took place via a sampling plan. The interviews were recorded, transcribed verbatim, and analysed by two trained researchers using qualitative content analysis.

Results: The change agents' perceived relevance of physical activity and physical activity promotion and their knowledge of physical activity recommendations varied across different sectors. Nine themes were identified covering the change agents' needs for the implementation of physical activity recommendations: strengthening of political will and cooperation, availability of public space for physical activity, change in awareness and health education, professional qualification, financial incentives, development of physical activity promoting programmes and structures, provision of resources, bridging the theory–practice gap, and knowledge of physical activity recommendations.

Conclusions: This exploratory study contributes to the development of an evidence-based dissemination strategy of physical activity recommendations involving change agents from various sectors. Cross-sectoral needs and obstacles were identified indicating gaps that have to be addressed. Future research should choose practice-oriented approaches to develop dissemination strategies that are adapted to the needs of local contexts.

Keywords: Physical activity recommendations, Physical activity guidelines, Dissemination strategy, Physical activity promotion, Change agent, Health promotion

Background

Numerous studies have shown that regular physical activity (PA) and reduced sitting habits have a positive impact on physical and mental health for people of all ages (Reiner et al., 2013). However, PA recommendations are reached by only a small part of the population. In Germany, for example, only about a quarter of children and adolescents are sufficiently active (Schmidt et al., 2020). The percentage is even lower in other parts of the world (Aubert et al., 2018) and other age groups (Krug et al., 2013). Lack of PA is not only responsible for 10% of all deaths (Hamer et al., 2017) but is also associated with increased economic burden (Centre for Economics and Business Research, 2015; Ding et al., 2016).

Recently, the German Federal Ministry of Health published the German National Recommendations for Physical Activity and Physical Activity Promotion (NRPP) (Rütten &

Pfeifer, 2016). An update of the WHO guidelines on PA and sedentary behaviour was launched as well (World Health Organization, 2020). However, a common problem is that research findings on public health-related topics such as PA promotion are oftentimes not translated into practice, resulting in a research–practice gap (Ballew et al., 2010; Brownson, Ballew, Dieffenderfer, et al., 2007; Davis et al., 2017). Consequently, there is a strong need to develop strategies on how to bridge the gap and implement PA recommendations in specific settings (Ballew et al., 2010; Bauman et al., 2006; Davis et al., 2017; Pollack et al., 2016).

To change people's PA behaviour and to implement PA recommendations, it is important to change the relevant environmental conditions. This is based on the socio-ecological paradigm which postulates that human behaviour takes place in interrelated and complex ecological systems (Kok et al., 2008; McLeroy, 2006; Sallis et al., 2006; Trochim et al., 2006). The systems perspective acknowledges that people live, work, and learn in different multilayered environments (interpersonal, organizational, community, societal). These environmental conditions include social influences, such as social support or social norms, and structural influences, such as spatial conditions and available resources.

Environmental conditions are often under the control of change agents acting on different levels of the socio-ecological model: interpersonal (e.g., teachers), organizational (e.g., sports clubs administrators), community (e.g., urban planners), and societal (e.g., politicians at the national level). Based on theories of organizational change and development, different levels of change agents have to be considered (Butterfoss et al., 2008): Actors at a higher level can initiate other processes, such as exercising decision-making power and passing laws, than actors at a lower level, who usually have direct contact with target groups and use their professional skills in interacting with them. Change agents may act as role models (Babey et al., 2016; Bauman et al., 2006), decision-makers (Dobbins et al., 2009; Rütten et al., 2018) and/or knowledge mediators (Ballew et al., 2010). According to the diffusion of innovations theory, the adoption and implementation of an innovation, such as PA recommendations, depends on the position of individual change agents in the innovation decision process, which is divided into five phases: knowledge of innovation, persuasion of innovation (positive or negative), decision for or against innovation, implementation of innovation, and confirmation of implementation decision (Rogers, 2003).

Consequently, to implement PA recommendations by changing the environmental conditions, one must impact the change agents' behaviour. The involvement of relevant stakeholders (Davis et al., 2017; Latimer-Cheung et al., 2013; Muellmann et al., 2017; Rütten et al., 2018), such as change agents (Bartholomew Eldredge et al., 2016; Simons-Morton et al., 1988), is a common strategy to implement PA recommendations in specific settings, as they have the necessary knowledge of contextual factors. They can give valuable practical insights and draw attention to real-world challenges to develop measures that are adapted to local contexts (Ballew et al., 2010; Davis et al., 2017; Piercy et al., 2015; van Rinsum et al., 2017). In addition to implementing concrete measures, change agents may also take on other roles in public policy processes (Brewer & DeLeon, 1983; Lasswell, 1956). While actors with political decision-making power on a national level can influence agenda-setting, actors from the research community can participate in policy formulation (Giles-Corti et al., 2015; Piercy et al., 2015; van Rinsum et al., 2017).

However, dissemination and implementation of PA recommendation are often prevented by two failures: (1) Until now, they have neglected to involve all important sectors of society in PA promotion plans (Leone & Pesce, 2017). Although PA recommendations are often published by the health sector, their implementation is the responsibility of other sectors such as education, sport, and urban planning, which are generally rarely considered (Haggis et al., 2013; van Rinsum et al., 2017; Woolf et al., 2015). Additionally, socio-ecological models call for multilevel and multisectoral interventions to bring about a sustainable change in environments favourable to PA behaviour (Bartholomew Eldredge et al., 2016; Sallis et al., 2006). However, until now, studies have often focused exclusively on change agents from the health sector (Ballew et al., 2010; Brownson, Ballew, Brown, et al., 2007; Piercy et al., 2015) or only on individual settings such as schools (Cooper et al., 2016) or the built environment (Giles-Corti et al., 2015). (2) The individual perceptions, attitudes, and needs of change agents have not been sufficiently taken into account (Leone & Pesce, 2017). To enable change agents to promote PA and implement PA recommendations, health promoters and scientists should identify the factors that facilitate or hinder PA-promoting activities in change agents. This should include facilitators and barriers on the personal and environmental levels (Bartholomew Eldredge et al., 2016). The survey of change agents' needs allows for deriving recommendations for action with regard to which cross-population and

setting-specific measures are necessary to implement PA recommendations. Needs cover demands of change agents that can be assigned to different levels of the socio-ecological model. In the following, a distinction is made between needs on the policy level and needs in certain behaviour settings. The former are defined as mainly indirect requirements aimed at changing policies concerning social and political issues. The latter refer to specific and personal demands in certain settings.

The purpose of this study is to address the problem of how national PA recommendations can be translated into practice through a comprehensive consideration of the situation and context of change agents promoting PA. There is a strong need to involve change agents in sectors of society other than the health sector and to focus on various settings when developing dissemination strategies for PA recommendations (Brownson, Ballew, Brown, et al., 2007). To identify the facilitators of and barriers to their behaviour, it is paramount to first survey the change agents' perceived relevance of PA and PA promotion, their knowledge of PA promotion and PA recommendations, and their needs for implementing these recommendations.

Therefore, this study aimed to develop recommendations for action on how a national strategy for dissemination of PA recommendations including relevant change agents should be designed by (a) investigating the change agents' perceived relevance and knowledge with regard to PA and PA promotion, and (b) analysing their needs with regard to the implementation of the NRPP in specific settings.

Methods

Study design

We chose an exploratory, qualitative approach, as little is known about this research area so far. The study took place in Germany, a country in central Europe with a population of about 83 million. Between October 2019 and April 2020, in-depth semi-structured expert interviews (Gläser & Laudel, 2010) were conducted to gain insight into the perceived relevance and knowledge as well as needs of change agents promoting PA. This approach is an adequate method to extensively record the participants' backgrounds, motivations, and explanations about a specific social phenomenon.

The interview guide included the following questions:

- What is the change agents' perceived relevance of PA in society? How important is PA and PA promotion in the change agents' organizations?
- What knowledge do change agents have regarding PA effects and PA promotion? Are they aware of the NRPP?
- Who are the change agents' target groups?
- What are the needs for implementing the NRPP in the change agents' specific settings?
- What are the problems and obstacles change agents encounter in implementing the NRPP?
- How do change agents assess their capabilities and potential for the implementation of the NRPP?

Procedure and recruitment

The experts were selected based on existing and potential change agents of PA promotion in Germany identified in the SAMBA [Systematische Erfassung relevanter Akteure, Berufsgruppen sowie künftiger Multiplikatoren in der Bewegungsförderung zur Analyse und Entwicklung eines interdisziplinären Netzwerks zur nachhaltigen Bewegungsförderung] study (Wäsche et al., 2018). In this study, different environmental conditions influencing individual PA behaviour were taken into account (interpersonal, organizational, community, societal), resulting in a compilation of change agents from a variety of sectors of society (politics and administration, health, sport/nonprofit, sport/for-profit, economy, media, education and research, social affairs) at different administrative levels (national level, state level, community level).

To ensure multisectoral representativity regarding PA promotion, we took the following sectors and change agents into consideration, which were derived from the SAMBA study (Wäsche et al., 2018):

- Politics and administration: politicians, ministries, and departments at the national, state, and community levels; urban, transport, and landscape planning; health conferences at the state and community levels, etc.
- Sport/nonprofit: sports associations at the national and state levels, sports clubs, etc.
- Sport/for-profit: fitness industry, fitness centres, commercial sports providers, etc.

- Health: health insurance companies, occupational physicians, etc.
- Education and research: universities, colleges, schools, kindergartens, adult education centres, sport scientists, etc.
- Economy: sporting goods manufacturers, corporate health management providers, etc.
- Social affairs: churches, community welfare organizations, etc.
- Media: media, actors, etc.

The case selection took place via a sampling plan. For this purpose, the previous list was taken as a basis and expanded in certain areas. We deliberately aimed at covering different administrative levels (community, state, and national level) in all relevant sectors of society and thus also the different levels of the socio-ecological model (Kok et al., 2008; Sallis et al., 2006). The participants were selected based on professional expertise. The expert status of the selected persons was discussed extensively within the project team prior to selection and contact to ensure that high-quality information could be generated. During the interviews, the experts repeatedly emphasized the importance of further actors, which were initially not considered in the sampling plan. Therefore, the plan was selectively expanded and additional experts were recruited. If an interview did not provide sufficient information on the specific sector of society, another expert from the relevant field was contacted.

The experts were recruited by email. In a cover letter, the participants received all relevant information regarding the background, content, and the planned procedure of the study. If participants did not answer, we followed up by telephone. Before the interview began, the experts were asked for their consent to the interview being recorded. They were also informed that their statements would be treated confidentially and made anonymous in the evaluation process. The interviews were conducted by two trained researchers.

Study sample

A total of 21 expert interviews were conducted (19 by telephone and two face-to-face interviews). On average, an interview lasted approximately 42 minutes (range 19–73 minutes). In two cases, the interviews took place with two experts (e.g., two staff members of the same organization) at the request of the interview partners, resulting in a

total of 23 experts. Seven of the respondents were female and 16 were male. Seventeen experts held management positions.

The composition of the experts with regard to the sectors of society and administrative levels was as follows (the respective *N* refers to the number of interviews, not to the number of experts):

- Politics and administration: national local-authority administration of cities, local department of urban planning (*N* = 2)
- Sport/nonprofit: national sports association, federal state sports association, local sports club (> 7000 members) (*N* = 3)
- Sport/for-profit: professional organization in the fitness industry, local fitness and health centre (*N* = 2)
- Health: health insurance company, occupational physician, primary care physician (*N* = 3)
- Education and research: national association of sport science, university (department of health science), school, kindergarten (*N* = 4)
- Economy: two sporting goods manufacturers, corporate health management provider (*N* = 3)
- Social affairs: church, city youth committee (*N* = 2)
- Media: national weekly news magazine, fitness and nutrition blogger (*N* = 2)

Data analysis

The interviews were recorded, transcribed verbatim, and read several times. In the transcribed interviews, the interviewees were anonymized and were marked with the abbreviations “B1” to “B21”, and the interviewer with the abbreviation “I”. In the interviews with two interviewees at the same time, a and b were added as suffixes. For transcription, the f4transkript software package was used.

To evaluate the interviews, the MAXQDA software package was used. We conducted a computer-aided structured qualitative content analysis (Elo & Kyngas, 2008; Mayring, 2000; Williamson & Johanson, 2018) with the aim of developing a category system to extract the relevant information to inform our study. While the main categories were deductively derived from the interview questions and therefore according to the research aims of this study, the subcategories were developed inductively drawing directly from the data material.

Since intercoder reliability is a critical component of qualitative content analysis, the transcripts were coded independently by two trained researchers in a circular process. Discrepancies were resolved by discussion. Based on intercoder agreement, 629 categories and subcategories were finally developed and interpreted. The definitions of the main categories were based on the following dimensions: perceived relevance of PA and PA promotion; knowledge of PA effects, PA promotion, and the NRPP; target groups of change agents; needs for the implementation of the NRPP; problems and obstacles to implementing the NRPP; and potential and capabilities as a change agent.

Results

To answer the research questions, the six main categories developed were evaluated and summarized. Anonymized quotes from the interviewees are included as evidence. The information in brackets after each quote refers to the interview number, the respective paragraph of the interview, the sex of the interviewee, and the corresponding sector of society.

Perceived relevance of PA and PA promotion

For the change agents interviewed, the topic of PA and PA promotion was of high to very high relevance. No one considered the topic to be unimportant. The significance of PA and PA promotion for physical and mental health was most frequently cited (*N* = 14), especially for the prevention of diseases and avoidance of medication:

> *Physical activity and sports is actually the key to our health and is what everyone can do for themselves. On the one hand for physical health but also for mental health. […] [It] can also have the effect that each person can perhaps take less medication in his life.* (B6, 10, female, media)

Moreover, the effect of PA supporting social interaction and cohesion (*N* = 3), the essential roles of PA in the motor development, socialization process, and holistic learning of children and adolescents (*N* = 4), and the importance of PA for the de-escalation of violence (*N* = 1) were emphasized. The economic relevance of PA promotion was mentioned by one change agent from the sport/for-profit sector.

More than half of the change agents surveyed rated the importance of PA and PA promotion in their occupation and organization as high (*N* = 11). Two change agents from the politics and administration sector and media sector assigned a medium value

to the topic, as it was one of many issues their organization was dealing with. The change agents from the sporting goods industry and urban planning department indicated that PA promotion played no or only a subordinate role in their organization (*N* = 3). Although it had a high priority internally for one of the representatives of the sporting goods industry, as it was part of their employee health management, it was considered not relevant for their external strategy. The interviewee pointed out that they were primarily a company that produces clothing and not a nonprofit organization promoting PA. According to him, it was only conceivable to take up PA promotion within the context of a marketing campaign. The representative of the urban planning department also reported having little contact with the topic of PA promotion but rather saw the responsibility in other community departments:

> *I actually have nothing to do with that, I mean the topic of physical activity promotion. Even regarding bicycle traffic, our focus is on overall urban mobility and the sustainability of traffic planning and not on health promotion.* (B20, 14, male, politics and administration)

The remaining five change agents could not be assigned to any of the three subcategories (high, medium, or low priority) as they presented a more differentiated view. While the primary care physician, for example, attached great importance to PA and PA promotion in her practice, she considered the importance in other medical practices as lower. The change agents from the school, the kindergarten, and the federal state sports association emphasized that the relevance of PA promotion was determined by the focus, orientation, and managerial staff of the individual organizations. According to the school representative, the importance of PA promotion depends mainly on how the school wants to advertise itself to the outside world to increase enrolment rates and is not intrinsically motivated.

Knowledge of PA effects, PA promotion, and the NRPP

Thirteen of the change agents rated their knowledge of PA effects and PA promotion as very good, four as good, three as average, and one interviewee reported having no knowledge at all in this field. The ones who assessed their knowledge as very good had most commonly completed a university degree in PA and sport sciences. Further backgrounds of knowledge acquisition included practical and professional experience as well as further education and training. Eleven change agents were familiar with the

NRPP, six of them were well acquainted with the content, one had basic knowledge, and four had only heard of the recommendations. The remaining 10 change agents (e.g., school, kindergarten, church, city youth committee, corporate health management provider) were unaware of the NRPP, but had already heard of the WHO PA recommendations (*N* = 5) or were unaware of any recommendations (*N* = 5).

Target groups of change agents

Target groups of change agents include individual and collective actors. The most frequently named individual actors were cited with regard to different life phases (infants, children, adolescents, and seniors) or with regard to their roles (pupils, students, employees, and parents). As collective actors, the most frequently mentioned target groups were companies, federal state sports associations, and sports clubs. Change agents from the politics and administration, education and research, health, sport/non-profit, and media sectors had a relatively broad target group, starting with children and adolescents, adults, and employees, up to senior citizens. Target groups of change agents from other sectors were more specific. Change agents from the sport/for-profit sector most frequently named adults, employees, competitive athletes, and people with health problems, while change agents from the social affairs sector targeted primarily young and old people: children, adolescents, and senior citizens. Target groups of the economic sector included not only employees but also politicians, other companies, and sports clubs. The change agents were in contact with their target group partly directly (*N* = 10) and partly indirectly via mediating instances (*N* = 11). The latter were predominantly change agents who were located at higher administrative levels.

Needs for the implementation of the NRPP

The needs of change agents regarding the dissemination and implementation of the NRPP were assigned to different environments (political, infrastructure, healthcare, workplace, sports and recreation, and information environment) and levels (policy level and behaviour setting level) of the socio-ecological model (Sallis et al., 2006) (see Table 1). While policy-level needs are mainly indirect requirements aimed at social or political changes, needs of behaviour settings denote more specific and personal demands. In the following, the requirements are assigned to different themes that emerged in the course of the analysis.

Table 1: Needs of change agents regarding NRPP implementation structured according to environments and levels

Political environment	**Infrastructure environment**	**Health care environment**	**Education environment**	**Workplace environment**	**Sports & recreation environment**	**Information environment**
			Policy level			
- Political will and responsibility at national level / Agenda setting PA promotion - Establishment of a federal institution responsible for PA promotion - Improvement of cooperation between ministries and political institutions - Strengthening of political significance of PA and sport sciences	- More public space for everyday life PA and unorganized sport (ensure lighting and safety) - Anchoring PA promotion in planning specifications of urban planners - Political focus away from car traffic to more PA-friendly mobility concepts	- Higher priority of PA promotion among spectrum of medical treatment - Financial incentives for physicians and health insurance companies regarding preventive measures	- Integrating PA promotion in vocational training of educational staff (schools, kindergartens, social institutions)	- Increasing tax allowance for companies investing in employee PA promotion	- Financial support for sports clubs engaging in PA promotion programs - Implementation of a quality seal for PA programs	- Change of society's awareness of importance of PA and strengthening of society's health literacy through nationwide media campaigns - Publicizing NRPP to target groups, general population, and change agents - Closer cooperation between science and practice

Behavior setting level						
- Empowerment of mayors and communities to implement the NRPP - Improvement of cooperation between decision-makers at the state and community level	- Change of awareness among urban planners regarding PA promotion	- More attractive reward systems and financial resources for individuals engaging in PA - Strengthening responsibility of physicians regarding PA promotion - More personnel resources and time capacities	- Change of awareness among educational staff regarding PA promotion - High-quality and multifaceted physical education / Imparting of health competences - Anchoring PA promotion in everyday school life - Cooperation with parents regarding PA and active mobility - More personnel and financial resources as well as time and spatial capacities - Socialization of children towards PA	- Change of organizational culture towards importance of PA (especially managers) - Workplace PA programs, PA promoting infrastructure, flexible working hours - More financial resources as well as time capacities	- Establishment of new sports clubs focusing on PA promotion - Offering of PA programs attractive to all age groups - More public programs within communities as well as digital PA programs - Health check-ups to provide structured guidance	- Practical information and working aids on how to implement the NRPP in specific settings - More compact, up-to-date, and comprehensible (online) presentation of the NRPP

Strengthening of political will and cooperation

The majority of change agents emphasized the importance of increasing the political will and support towards disseminating the NRPP and the need for central coordination and responsibility for PA promotion on a national level (*N* = 14). The topic should take a higher priority on the political agenda, as one change agent framed it:

> *One should really seriously put this issue of physical activity at the top of the agenda. If you look at scientific evidence, physical activity is so important that it is not high enough [on the political agenda]. This would be a first, very important step towards making it a top priority and ensuring that it is backed up by greater commitment and seriousness.* (B2b, 121, male, education and research)

According to two change agents (education and research, sport/nonprofit), the establishment of a national institution that is responsible for PA and PA promotion is necessary so that more personnel and financial resources are available at the political level. In addition, cooperation between existing federal ministries and political institutions as well as state- and community-level decision-makers involved in PA and PA promotion must be improved. One change agent, for example, considers it important to be better integrated into relevant networks:

> *Well, we would have to cooperate in a different way. […] It's a bit alarming that someone like me who is involved in this educational work didn't even know about your publication. And I don't know how the distribution works or how we could cooperate. It's interesting that we are working on the same interfaces, on the same topics; therefore, we should form a better network, be in contact with each other.* (B5, 52, male, social affairs)

On the level of behaviour settings, the political responsibility for implementing the NRPP was seen to lie with the communities and mayors (*N* = 2; politics and administration, sport/nonprofit). They can directly influence the living environment, put both setting-specific and life stage-specific measures into practice, and should thus be empowered:

> *After all, communities maintain a large number of institutions or even [...] community planning processes that are relevant in this area, whether it is community health planning, school development planning, and sports development planning,*

> *or urban development planning, where areas relevant for physical activity are also involved. […] This means that local authorities can transport this in their planning processes and through their institutions, they are responsible for kindergartens, they are responsible for schools, they are responsible for youth facilities, etc. […], and thus get relatively close to the people, to their neighbourhoods and where they live.* (B7, 58, male, politics and administration)

Availability of public space for PA

Concerning the infrastructure environment, the need for more public space for every-day-life PA and unorganized sport was emphasized (*N* = 5; diverse sectors). For one change agent, this is particularly important for young people:

> *Adolescents are fighting for every single [sports opportunity] in their district. And I think that this should actually be more natural, that it should simply be available to young people. Also that you simply establish public spaces in the city centre that encourage physical activity.* (B4, 70, female, social affairs)

As a possible solution, a change in the planning specifications was mentioned, so that a certain percentage of the planned area may not be built on but must be available for public PA.

Change in awareness and health education

Nearly all change agents (*N* = 17) emphasized that a change in society's awareness of the importance of PA and the provision of health education (*N* = 13) are required. For this purpose, the need for nationwide media campaigns promoting PA that involve a wide variety of media was stressed (*N* = 12): the use of social media and the promotion of PA via influencers was seen as particularly beneficial. Those campaigns should be centrally controlled by the federal government and involve different administrative levels:

> *Such a pervasive movement from the government, from this ministry accordingly through the DOSB [German Olympic Sports Confederation] into the population. So, not only through the experts in the sports clubs but directly to the citizen without a club or anything else being interposed, that would of course be super desirable. TV spots, social media, radio spots, a really broad movement accompanied by motivational programmes.* (B18, 52, male, sport/nonprofit)

The need for a change in awareness to implement national PA recommendations was mentioned not only concerning the overall population but also at the level of specific behaviour settings. This referred to educational staff and the management responsible for schools, kindergartens or social institutions (*N* = 6; diverse sectors), employers and managerial staff within the workplace environment (*N* = 5; diverse sectors), and physicians and healthcare staff (*N* = 4; education and research, health, sport/for-profit). Even the change agent from the urban planning department stated that it is not enough to just change the planning specifications, but also the awareness among urban planners:

> *But it is not yet in the minds of planners that the public space will be planned first and the parking lots and car traffic come second. In other words, the focus should be shifted away from the car and towards active mobility*. (B20, 42, male, politics and administration)

Professional qualification

Several change agents reported a need to better integrate PA and PA promotion into the vocational training of educational and healthcare staff, as these topics are currently underrepresented (*N* = 8; diverse sectors). Particularly with regard to schools, the need for sufficiently qualified teachers was emphasized, so that high-quality and multifaceted physical education including alternative ways of evaluation and lower levels of pressure to perform can support NRPP implementation in behaviour settings (*N* = 3; education and research, health). Moreover, all teachers should be capable of teaching health skills.

Some change agents argued that PA should become a larger part of the medicine course or further education of healthcare staff (*N* = 3; health, politics and administration). Physicians should become more aware of their function as role models and be able to make concrete recommendations to patients on how to increase PA behaviour (*N* = 4; education and research, health, sport/ for-profit):

> *I think that it would also be important that physicians are really qualified in the sector in a structured way and that they see the relevance for themselves and get involved. […] It is not enough just to say: "Do more sports". It should be done with emphasis. […] And simply producing colourful brochures or placing a website is just not enough. It has to be a chain. That the person [physician] does not just say*

> *“Do more sports”, but also “Where exactly and how exactly and why does it work for you”. It would be desirable that there is more structure in the whole thing.* (B2b, 142, male, education and research)

Financial incentives

The requirement for financial incentives to persuade change agents to engage in NRPP implementation was mentioned several times. Some change agents stated that physicians and health insurance companies should receive more financial incentives for prevention and less for repair medicine (*N* = 4; diverse sectors). One change agent demanded that physicians be able to charge for prescribing PA:

> *The problem which we get feedback on again and again is that it [prescribing PA] is still a voluntary service of physicians. Through the prevention law and through preventive medical checkups, it can be minimally charged for, but that is not what physicians want. So, it is an on-top service, and we find that in many federal states, sports physicians that are intrinsically motivated and have a sporting affinity use it very frequently, but with the average physician, there is still room for improvement. That is why we always demanded that it must be billable.* (B9, 104, male, sport/non-profit)

Concerning the workplace environment, the need for increasing the tax allowance for companies investing in the promotion of employee health and PA was mentioned (*N* = 2; sport/nonprofit). Moreover, within the sports and recreation environment, sports clubs that explicitly engage in NRPP implementation should be financially supported according to one change agent (sport/nonprofit).

On the level of behaviour settings, the provision of more attractive reward systems and financial resources for individuals achieving the NRPP was emphasized, to persuade people to take more personal responsibility for their health (*N* = 6; diverse sectors). The use of sanctions was also discussed, so that behaviour harmful to health has a negative effect on, for example, the amount of health insurance contributions. However, for some interviewees, this is too great a violation of privacy.

Development of PA-promoting programmes and structures

Eleven change agents considered the development of specific PA programmes as useful for the implementation of the NRPP. While some stressed the importance of

everyday exercise and fun-focused programmes, others demanded structured training programmes or called for new sports clubs that focus primarily on PA promotion. Even in existing sports clubs, the need for PA programmes for all age groups aimed at achieving the NRPP was emphasized (*N* = 4; education and research, sport/ nonprofit):

> *The problem I see in sports clubs is often that they do not have adequate and attractive exercise programmes for middle-aged people. […] And I think that there must be attractive offers for all target groups in organized sport on a really comprehensive basis aiming at the implementation of physical activity recommendations and not just sport-specific programmes. For children and adolescents, especially for children when they are small, there must be a wide range of programmes that promote all motor skills equally.* (B2a, 130, male, education and research)

To meet the trend towards increasing self-organized PA, some change agents emphasized the need for more digital programmes accessible to everyone (*N* = 5; diverse sectors) as well as public programmes within communities that are connected to the natural living environment (*N* = 4; education and research, health, politics and administration):

> *There is already a trend towards physical activity; however, there is less willingness to commit oneself to any kind of sports club but more to the selforganized sport, which can be promoted by creating appropriate sports opportunities that have an inviting character.* (B7, 32, male, politics and administration)

One change agent (sport/for-profit) emphasized the policy-level need for developing a universally applicable quality seal so that high-quality PA programmes can be distinguished from lower-quality programmes to keep people from choosing PA programmes that are not suitable for them.

Apart from the development of PA programmes, the provision of PA-supporting structures in settings such as kindergartens, schools, and workplaces was seen as important. Seven change agents emphasized not only the availability of workplace PA programmes as a need, but also the provision of a PA-promoting infrastructure and flexible working hours. The same applies to schools, where PA programmes should be firmly anchored in every day's schedule.

Provision of resources

To firmly anchor PA-promoting structures and programmes in diverse behaviour settings such as schools, kindergartens, workplaces, or doctors' practices, the need for more resources was expressed. Several change agents from different sectors of society (especially from the education and research sector) called for more personnel and financial resources as well as time and spatial capacities to implement the NRPP in kindergartens and schools. The need for more personnel resources and time capacities was also mentioned by the primary care physician.

Bridging the theory–practice gap

Seven change agents (diverse sectors) pointed out a theory– practice gap and demanded a translation of the scientific findings of the NRPP into concrete dissemination strategies:

> *We already have certain instruments and we have good structural conditions and these must now be used. And it is very important to make a transfer to practice and to really provide the practice with something useful and not just scientific findings that are reflected in some great publications with impact factor and so on. This is all-important for science but does little for practice and for the mission to get people moving.* (B9, 93, male, sport/nonprofit)

This would require closer cooperation between science and practice and higher participation of the target group when designing measures. One change agent from the economic sector expressed the need for practice-oriented scientific studies and communication of their results:

> *Well, I would perhaps wish that scientific studies would look a little more into reality. To say, I'll give you an example, […] if I do certain exercises for 5 minutes a day at my workplace, is that enough, or how often do I have to do it to compensate for something. […] Because if I know that something can be done in shorter units, then I could also better persuade employers to say, "Integrate it during the day".* (B14, 58-62, male, economy)

Some change agents expressed the need for practical information such as methodological kits, working aids, practical instruments, and structures that support actors close to the target group, for example, in organizing daily routines of PA promotion in their

setting but also in applying for PA projects or communicating PA recommendations adequately (*N* = 3; education and research, sport/nonprofit).

Knowledge of PA recommendations

The need for communicating the NRPP to the general population, specific target groups, and other change agents was repeatedly mentioned (*N* = 7; diverse sectors). It was pointed out that a more compact and comprehensible presentation of the most important points via a website would be necessary. The recommendations should also have an up-to-date appearance and be distributed via as many press mailing lists as possible, both referring to a new website and sending the recommendations directly:

> *I believe that if you would present it a little differently, we would simply address it much more often. Our reporting would also refer to it much more often. To do so, you would have to pick out the key points, i.e., the message to the people out there, and put it together in a compact form. [...] So if you manage to distill the most important messages to the people out there as concretely but also as concisely as possible and also present them well on the Internet, then we can refer to them much better. We can link to it again and again, and yes, I think that would also make it much better known.* (B6, 48, female, media)

Problems and obstacles to implementing the NRPP

Problems and obstacles to implementing the NRPP mentioned by the change agents concern the political, healthcare, education, and sports and recreation environment.

Within the political environment, federalism was seen as an obstacle, as it often prevents the implementation of centrally controlled measures and programmes (*N* = 1; sport/nonprofit). Five change agents (education and research, social affairs, sport/nonprofit) also saw the lengthy decision-making processes at various political levels as a hindrance when implementing measures to promote PA.

Concerning the healthcare environment, the situation of health insurance companies was seen as problematic, as they are in a competitive situation with each other. Thus, their focus would be on one-off marketing campaigns to recruit new members and not on sustainable implementation of the NRPP:

> *It is simply also the false incentives for health insurance companies. On the one hand, they are in competition with each other. On the other hand, they are supposed to do preventive work, and you can see it in the workplace settings, […] that is where a health insurance company can also support people who were insured with a competing insurance company. And that of course [leads] to the fact that they […] do marketing measures there. In other words, they always focus on how to recruit new members. So they do measures that reach a lot of employees at once […]. That means that the whole thing goes in the wrong direction with such a false incentive. They should rather be given an incentive to implement these national recommendations.* (B14, 98, male, economy)

The change agent from the health insurance company took a different view and believed that they already integrate the NRPP sustainably in many areas. However, she also admitted that closer cooperation with the scientific community is necessary and that they need political backing and financial support from the taxpayer for the implementation of structural measures.

Obstacles identified in the medical field were linked to medical progress and the dominance of the pharmaceutical lobby and industry (*N* = 3; health, economy). Often, medication would be prescribed to alleviate symptoms rather than to prevent the cause of diseases by promoting PA, as framed by one change agent:

> *One problem I see is that medical progress is so good, so if I can insert a stent after all, why should I do cardiovascular prevention? Well, repair medicine is great on the one hand, of course. I don't need to be physically active. It'll be repaired somehow. But humans are programmed to be active, and at some point in the evolutionary process something must have gone wrong.* (B16, 65, female, health)

Concerning the education environment, excessively rigid daily routines in kindergartens and the participatory approach to children's daily planning were identified as problems (*N* = 2; education and research, sport/ nonprofit):

> *Another reason is that we have a participatory approach. So, the children can decide almost everything freely and individually. And there are always enough offers that have nothing to do with physical activity because there is simply a very broad spectrum. And that's why you can say that the recommendation is perhaps fulfilled by children who are already very much interested in physical activity and always*

> *choose active programmes, but with the others… if they choose rather sedentary offers […] in the kindergarten, then most of the day is already over, and I don't think they would somehow make up for the rest of the day.* (B8, 102, male, education and research)

In the school setting, the frequent cancellation of physical education classes and the fact that classes, especially in primary schools, would be taught by unqualified teachers were identified as obstacles to the implementation of the NRPP. The performance orientation in physical education would also leave little time for the explicit implementation of the NRPP (*N* = 4; diverse sectors). Overall, many expectations were placed on the education system and especially on the school environment and physical education classes. However, the interviewee from the school setting pointed out that physical education cannot meet all the demands that are not met by other subjects. Students' social environment would often be neglected, and schools would have little influence on whether and how children are socialized to sport by their parents.

Regarding the sports and recreation environment, permanent pricing pressure was identified as a problem within the fitness industry, where PA offers have to be as affordable as possible. As a result, the qualification of the personnel would suffer, so that a sustainable orientation towards health and PA promotion is rarely given (*N* = 2; sport/for-profit, sport/nonprofit). Another obstacle emphasized by one change agent regarding organized sport was the focus of sports associations and clubs on competition and on talent identification and recruitment rather than on PA promotion:

> *But I always emphasize that 90, 95, 98% of the people who volunteer [in sports clubs] do so basically because they love their sport: soccer, handball, whatever it is. And why should they suddenly want something that doesn't really benefit their sport at first sight.* (B21, 78, male, sport/nonprofit)

Potential and capabilities as a change agent

The majority of the change agents assessed their potential and capabilities regarding the dissemination of the NRPP as positive. While some believed that they can contribute to raising awareness regarding the NRPP, providing knowledge about PA and PA promotion (*N* = 6; diverse sectors), and qualifying specialists in the field of PA promotion (*N* = 2; education and research), others make concrete suggestions regarding PA to the target group (*N* = 2; health, sport/for-profit), contribute to motivating them (*N* =

3; economy, education and research, media), act as role models (*N* = 2; health, media), or can influence the conditions for implementing the NRPP (*N* = 2; education and research, sport/nonprofit). As a prerequisite for this, however, some also emphasized that the needs mentioned must be met at various levels. Four change agents were sceptical about their capacity to disseminate the NRPP (economy, health, sport/for-profit, sport/nonprofit). Although the importance of physicians in promoting PA was frequently emphasized, the primary care physician interviewed assessed her potential for influencing the PA behaviour of her patients as limited. Three change agents (social affairs, health, sport/nonprofit) perceived their influence rather indirectly as a creeping process and as one of many factors that can influence the PA behaviour of their target group.

Discussion

The purpose of this study was to address the problem of how national PA recommendations can be translated into practice involving change agents of PA promotion. Through a comprehensive consideration of their situation and context, we identified facilitators and obstacles that have to be considered in dissemination strategies. Recommendations for action are highlighted in italics. A summary of the recommended actions is provided in Additional file 1.

The first aim of this study was to investigate the change agents' perceived relevance and knowledge concerning PA and PA promotion. Overall, PA and PA promotion were of high to very high perceived relevance to all change agents. Although scientific studies show that the economic relevance of PA is considerable (Centre for Economics and Business Research, 2015; Ding et al., 2016), only one change agent mentioned this as a motive for engaging in PA promotion. To strengthen the importance of PA promotion, especially at the political level, it seems necessary to focus more on the financial consequences of a lack of PA and to communicate the results of relevant studies to decision-makers.

In their occupation and organization, about half of the change agents assigned high priority to PA and PA promotion. The topic was of low relevance to the sporting goods manufacturers and the department of urban planning. Due to their high level of popularity and their marketing budget, sporting goods manufacturers, in particular, have great potential for the dissemination of PA recommendations (World Health

Organization, 2004). Actors that are not directly involved in health and PA promotion often do not realize that they play a significant role in this context (van Rinsum et al., 2017). It is therefore important to *develop strategies on how to integrate such change agents from non-health sectors into networks of PA promotion*. Concerning sporting goods manufacturers, a decisive step would be to give prominence to the *economic advantages of an engagement in PA promotion*, for example, taking up the topic in a marketing campaign. To persuade stakeholders in urban and transport planning, it is important to *present the topic in a broader context*, such as emphasizing quality of life instead of PA promotion, and to focus on the *ecological relevance* of PA promotion, such as sustainable mobility and climate protection (Leone & Pesce, 2017).

Some change agents delegated responsibility for disseminating PA recommendations to other authorities, emphasizing that the relevance of PA and PA promotion is not in their hands but depends heavily on political decisions and the focus and management of individual institutions. A lack of coordination, the absence of a strategic plan, and the failure to take responsibility are phenomena frequently observed in other countries as well, hampering the dissemination of national PA recommendations (Bornstein et al., 2009; Spence et al., 2015). At this point, it is important to *better involve change agents in dissemination strategies* and to appeal to their personal responsibility for implementing PA recommendations.

Although the majority of change agents rated their knowledge in the field of PA effects and PA promotion as good or very good, about half had not yet heard of the NRPP. Strikingly, this concerned some change agents from the educational, social, and work-place environment who have direct contact with target groups. It seems that there is an intuitive rather than a systematic approach to NRPP implementation in Germany. One of the next steps should be to *make the NRPP known across sectors*, with a special focus on change agents interacting directly with relevant target groups in order to bring more structure into the dissemination and implementation process.

The second aim of this study was to analyse the change agents' needs with regard to the implementation of the NRPP in specific settings. To give NRPP dissemination a *higher priority on the political agenda*, the establishment of a *national authority responsible for PA promotion* is needed. Furthermore, there needs to be *closer cooperation and networking of relevant change agents at the national, state, and community levels*

to tackle PA promotion collectively. This is in line with the demands of previous research to form intersectoral networks to solve complex health problems, such as physical inactivity, by combining core competencies and resources, creating synergies, and working more effectively on solutions involving different perspectives (Bevc et al., 2015; Provan & Milward, 2001; Wäsche et al., 2018; World Health Organization, 2018). Drawing on findings from research on network governance (Provan & Kenis, 2007), a central institution for PA might act as an administrative unit that initiates and manages multisectoral networks of relevant actors at the national level. In this way, it could take the leadership role concerning the implementation and evaluation of PA promotion.

Within the infrastructure environment, *more public PA spaces are needed*. Here, urban and landscape planning play an important role. Not only should the planning specifications be changed regarding the design of PA-promoting environments, but there must also be a change in awareness so that urban planners become aware of their responsibility concerning the implementation of the NRPP.

PA and PA promotion should become a larger part of the *vocational training of educational and healthcare staff*, as these topics seem to be currently underrepresented. In particular, teaching staff need to be adequately qualified with regard to *high-quality and multifaceted physical education* in which health skills are taught.

Overall, *more financial incentives* should be provided for the dissemination of the NRPP with regard to different target groups. In the health sector, a *stronger focus on disease prevention* is required (Vuori et al., 2013). Physicians should be able to charge for the prescription of PA, and health insurance companies should be rewarded for realizing sustainable NRPP implementation. More attractive reward systems for individuals as well as financial incentives for sports clubs and companies to engage in PA promotion were also suggested. To ensure that more financial resources are available regarding PA promotion, again a national institute for PA that has the appropriate resources would be important.

To ensure that greater attention is paid to the topic of PA promotion, a *change in social norms and awareness as well as health education* are needed so that the importance of PA and sport is anchored in the consciousness throughout society but also in specific settings. This requires, among other things, a *clearly elaborated communication concept that is disseminated through media campaigns*, especially involving social

media. However, it has to be taken into account that the effectiveness of stand-alone mass-media campaigns in PA promotion is still unclear. It seems more effective to embed such campaigns into broader multicomponent interventions (Brown et al., 2012). Also, care should be taken to comprehensively cover all relevant content of PA recommendations and to develop different communication concepts for different target groups (Maddock & Kellstedt, 2020). In addition, there should be a *comprehensible and compact online representation of national PA recommendations* which is easily accessible to everyone.

The findings show that there is disagreement as to whether structured training programmes or fun-focused PA in everyday life are more effective in implementing the NRPP. Among other things, this highlights the need for *concrete information, working aids, and methodological kits* that can support change agents in implementing suitable, scientifically based measures of PA promotion. It is essential for this purpose that change agents are addressed in a *transdisciplinary approach of science and practice* to translate the scientific findings of the NRPP into political implementation strategies, medical treatment strategies, and specific PA-promoting measures useful in practice tailored to the respective setting (Glasgow & Emmons, 2007). Such an approach could also lead to change agents taking more responsibility for the implementation of jointly developed programmes.

Besides the *provision of more attractive PA programmes for all age groups provided by sports clubs and the development of easily accessible public and digital PA programmes*, the implementation of *PA recommendations should be structurally anchored* in the settings where people live, learn, and work. This includes the *establishment of a PA-friendly organizational culture and flexible working hours* by employers as well as *PA breaks and programmes that are firmly anchored in the daily routine of educational institutions*, supported by the respective management.

Schools, kindergartens, and organized sport are considered central settings for PA promotion (Rütten & Pfeifer, 2016). However, the respective change agents point out some problems that currently hamper the implementation of the NRPP, such as too rigid daily routines, a lack of staff qualifications, a lack of space (e.g., gymnasiums and swimming pools), the cancellation of physical education, the shortage of financial resources, and a lack of awareness on the part of kindergarten, school, and sports club

administrators. In addition, performance orientation in physical education and sports clubs would leave very little room for more general approaches to PA promotion. These findings are also supported by existing literature (Hills et al., 2015; Skille, 2010). In this context, it is even more important to *appeal to the personal responsibility of sports clubs and educational institutions* to critically question their performance orientation and to better fulfil their educational and social mission (Geidne et al., 2019; Hills et al., 2015; Kokko, 2014; Lozano-Sufrategui et al., 2020).

To solve obstacles to the dissemination and implementation of PA recommendations in settings such as educational institutions, the workplace, or the healthcare setting, *appropriate resources have to be provided*. These can ensure that the personnel, time, and spatial capacities needed to carry out adequate PA promotion are covered.

Referring back to diffusion of innovations theory (Rogers, 2003), one could assign the change agents and their needs to the different phases of the innovation decision process (Figure 1). Change agents have different needs depending on the stage they are in, and therefore they have to be addressed accordingly to successfully involve them in the dissemination and implementation of PA recommendations. Since some change agents had not yet heard of the NRPP or even had no connection to the topic of PA promotion, such as the representative of the urban planning department, we added a further phase to the model: the ignorance phase. Change agents in this phase need to be informed about PA recommendations and their applicability in the first place. In addition, they should become aware that PA promotion is a relevant topic to them so that they move on to the knowledge and persuasion phase. One of the sporting goods manufacturers was convinced that the NRPP and PA promotion are something worth striving for but had not yet decided to engage in NRPP dissemination, which is why he could be assigned to the persuasion phase. To move on to the decision phase, change agents must be made aware of the advantages of an engagement in the dissemination of PA recommendations, for example, by *focusing on the economic, societal, or ecological benefits*. Change agents in the decision phase, such as the primary care physician, were willing to implement the NRPP but had not yet proceeded systematically. At this stage, appropriate financial resources, working aids, and practicable information that support change agents in implementing PA recommendations are needed. Some change agents (e.g., from the fitness and health centre or the health insurance company) could be assigned to the implementation phase, since they use the NRPP in a

structured way in their daily work. These change agents need to be supported through appropriate resources and political backing to keep their implementation decision valid.

The study findings show that on the one hand, change agents need to take on more responsibility for implementing PA recommendations. On the other hand, for change agents to become active at all, certain requirements, such as agenda-setting or provision of resources, must be met at a higher level so that environments and conditions are favourable to this dynamic. Therefore, both the involvement of change agents and the whole organization of the system are determinants for the dissemination of PA recommendations.

The major strength of this study is the consideration of needs on the policy and behaviour setting level going beyond individual sectors of society: The present study is one of the first to involve stakeholders from various sectors of society and administrative levels in the development of a national dissemination strategy of PA recommendations. Furthermore, extensive data material was collected and analysed, ensuring high credibility of the study findings. Transferability was guaranteed through a thick description of contextual conditions and participants surveyed. Finally, intercoder reliability and self-reflection of the researchers during the research process ensured dependability and confirmability of the study findings. However, some limitations have to be mentioned: The study findings cannot be readily generalized. The change agents' statements are based on subjective opinions, depending on their individual situation and context. Thus, some of the needs cited might be linked to predominant conditions (organizational structure, relevance of PA promotion, financial, spatial, and personnel capacities) of specific settings. Moreover, the majority of respondents were male. A greater diversity of interviewees and a more balanced ratio of women and men may have led to additional or different needs related to NRPP dissemination. To verify whether these findings are representative and applicable to other organizations of the same type, in-depth needs analysis of individual settings are necessary. Finally, the aspect of social desirability based on the interview situation must be taken into account. When asking the respondents about their motives for an engagement in PA promotion, altruistic motives such as health promotion may have been given preference over, for example, economic motives.

Figure 1: Innovation decision process towards NRPP implementation (modified according to Rogers (2003))

Conclusions

This study enables a differentiated consideration of the perceived relevance, knowledge, and needs of change agents concerning the dissemination and implementation of the NRPP in Germany. Change agents, acting as decision-makers, knowledge mediators, and role models, from diverse sectors of society were taken into consideration. To our knowledge, this is the first study which covers different administrative levels and all sectors of society relevant to PA promotion. This exploratory study is an important step towards developing an evidence-based strategy for dissemination of PA recommendations involving various change agents of PA promotion. Even though each of the sectors under consideration has different goals and a more or less close connection to the topic of PA promotion, many cross-sectoral needs and obstacles were identified. They indicate gaps that need to be addressed and closed in dissemination strategies for PA recommendations. Taking into account their attitudes toward PA promotion and their needs regarding the implementation of PA recommendations, change agents and their respective environments should be addressed accordingly to engage them most effectively. Future research should identify the needs of specific settings in a representative way and develop concrete measures on how to involve change agents in the dissemination and implementation of PA recommendations. It is particularly important to choose transdisciplinary approaches of research and practice so that measures are adapted to the needs of local contexts. As PA promotion is a challenge that needs to be tackled by multisectoral cooperation, the study of the interactions of change agents on different levels might produce valuable insights regarding collaborative policy formulation and implementation. In addition, an evaluation of the success of policy development and dissemination strategies involving change agents in Germany and other countries is needed.

References

Aubert, S., Barnes, J. D., Abdeta, C., Abi Nader, P., Adeniyi, A. F., Aguilar-Farias, N., Andrade Tenesaca, D. S., Bhawra, J., Brazo-Sayavera, J., Cardon, G., Chang, C.-K., Delisle Nyström, C., Demetriou, Y., Draper, C. E., Edwards, L., Emeljanovas, A., Gába, A., Galaviz, K. I., González, S. A., . . . Tremblay, M. S. (2018). Global matrix 3.0 physical activity report card grades for children and

youth: Results and analysis from 49 countries. *Journal of Physical Activity & Health*, *15*(Suppl. 2), 251-273. https://doi.org/10.1123/jpah.2018-0472

Babey, S. H., Wolstein, J., & Diamant, A. L. (2016). Adolescent physical activity: Role of school support, role models, and social participation in racial and income disparities. *Environment and Behavior*, *48*(1), 172–191. https://doi.org/10.1177/0013916515609086

Ballew, P., Brownson, R. C., Haire-Joshu, D., Heath, G. W., & Kreuter, M. W. (2010). Dissemination of effective physical activity interventions: Are we applying the evidence? *Health Education Research*, *25*(2), 185–198. https://doi.org/10.1093/her/cyq003

Bartholomew Eldredge, L. K., Markham, C. M., Ruiter, R. A. C., Fernández, M. E., Kok, G., & Parcel, G. S. (2016). *Planning health promotion programs: An intervention mapping approach* (4th ed.). Jossey-Bass.

Bauman, A. E., Nelson, D. E., Pratt, M., Matsudo, V., & Schoeppe, S. (2006). Dissemination of physical activity evidence, programs, policies, and surveillance in the international public health arena. *American Journal of Preventive Medicine*, *31*(4, Suppl.), S57–S65. https://doi.org/10.1016/j.amepre.2006.06.026

Bevc, C. A., Retrum, J. H., & Varda, D. M. (2015). Patterns in PARTNERing across public health collaboratives. *International Journal of Environmental Research and Public Health*, *12*(10), 12412–12425. https://doi.org/10.3390/ijerph121012412

Bornstein, D. B., Pate, R. R., & Pratt, M. (2009). A review of the national physical activity plans of six countries. *Journal of Physical Activity & Health*, *6*(Suppl. 2), 245-264. https://doi.org/10.1123/jpah.6.s2.s245

Brewer, G. D., & DeLeon, P. (1983). *The foundations of policy analysis*. Brooks/Cole.

Brown, D. R., Soares, J., Epping, J. M., Lankford, T. J., Wallace, J. S., Hopkins, D., Buchanan, L. R., & Orleans, C. T. (2012). Stand-alone mass media campaigns to increase physical activity: A Community Guide updated review. *American Journal of Preventive Medicine*, *43*(5), 551–561. https://doi.org/10.1016/j.amepre.2012.07.035

Brownson, R. C., Ballew, P., Brown, K. L., Elliott, M. B., Haire-Joshu, D., Heath, G. W., & Kreuter, M. W. (2007). The effect of disseminating evidence-based interventions that promote physical activity to health departments.

American Journal of Public Health, *97*(10), 1900–1907. https://doi.org/10.2105/AJPH.2006.090399

Brownson, R. C., Ballew, P., Dieffenderfer, B., Haire-Joshu, D., Heath, G. W., Kreuter, M. W., & Myers, B. A. (2007). Evidence-based interventions to promote physical activity: What contributes to dissemination by state health departments. *American Journal of Preventive Medicine*, *33*(1, Suppl.), S66-S73. https://doi.org/10.1016/j.amepre.2007.03.011

Butterfoss, F. D., Kegler, M. C., & Francisco, V. T. (2008). Mobilizing organizations for health promotion: Theories of organizational change. In K. Glanz, B. K. Rimer, & K. Viswanath (Eds.), *Health behaviour and health education: Theory, research and practice* (4th ed., pp. 335–361). John Wiley.

Centre for Economics and Business Research. (2015). *The economic cost of physical inactivity in Europe: An ISCA/Cebr report*. https://inactivity-time-bomb.nowwemove.com/report/

Cooper, K. H., Greenberg, J. D., Castelli, D. M., Barton, M., Martin, S. B., & Morrow, J.R., Jr. (2016). Implementing policies to enhance physical education and physical activity in schools. *Research Quarterly for Exercise and Sport*, *87*(2), 133–140. https://doi.org/10.1080/02701367.2016.1164009

Davis, S. M., Cruz, T. H., & Kozoll, R. L. (2017). Research to practice: Implementing physical activity recommendations. *American Journal of Preventive Medicine*, *52*(3.3, Suppl.), S300-S303. https://doi.org/10.1016/j.amepre.2016.09.028

Ding, D., Lawson, K. D., Kolbe-Alexander, T. L., Finkelstein, E. A., Katzmarzyk, P. T., van Mechelen, W., & Pratt, M. (2016). The economic burden of physical inactivity: A global analysis of major non-communicable diseases. *The Lancet*, *388*(10051), 1311–1324. https://doi.org/10.1016/S0140-6736(16)30383-X

Dobbins, M., Robeson, P., Ciliska, D., Hanna, S., Cameron, R., O'Mara, L., DeCorby, K., & Mercer, S. (2009). A description of a knowledge broker role implemented as part of a randomized controlled trial evaluating three knowledge translation strategies. *Implementation Science*, *4*, Article 23. https://doi.org/10.1186/1748-5908-4-23

Elo, S., & Kyngas, H. (2008). The qualitative content analysis process. *Journal of Advanced Nursing*, *62*(1), 107–115. https://doi.org/10.1111/j.1365-2648.2007.04569.x

Geidne, S., Kokko, S., Lane, A., Ooms, L., Vuillemin, A., Seghers, J., Koski, P., Kudlacek, M., Johnson, S., & van Hoye, A. (2019). Health promotion interventions in sports clubs: Can we talk about a setting-based approach? A systematic mapping review. *Health Education & Behavior*, *46*(4), 592–601. https://doi.org/10.1177/1090198119831749

Giles-Corti, B., Sallis, J. F., Sugiyama, T., Frank, L. D., Lowe, M., & Owen, N. (2015). Translating active living research into policy and practice: One important pathway to chronic disease prevention. *Journal of Public Health Policy*, *36*(2), 231–243. https://doi.org/10.1057/jphp.2014.53

Gläser, J., & Laudel, G. (2010). *Experteninterviews und qualitative Inhaltsanalyse als Instrumente rekonstruierender Untersuchungen* (4th ed.). VS Verlag. http://d-nb.info/1002141753/04

Glasgow, R. E., & Emmons, K. M. (2007). How can we increase translation of research into practice? Types of evidence needed. *Annual Review of Public Health*, *28*, 413–433. https://doi.org/10.1146/annurev.publhealth.28.021406.144145

Haggis, C., Sims-Gould, J., Winters, M., Gutteridge, K., & McKay, H. A. (2013). Sustained impact of community-based physical activity interventions: Key elements for success. *BMC Public Health*, *13*, Article 892. https://doi.org/10.1186/1471-2458-13-892

Hamer, M., O'Donovan, G., & Murphy, M. (2017). Physical inactivity and the economic and health burdens due to cardiovascular disease: Exercise as medicine. In J. Xiao (Ed.), *Exercise for cardiovascular disease prevention and treatment: From molecular to clinical, Part 1* (pp. 3–18). Springer Singapore. https://doi.org/10.1007/978-981-10-4307-9_1

Hills, A. P., Dengel, D. R., & Lubans, D. R. (2015). Supporting public health priorities: Recommendations for physical education and physical activity promotion in schools. *Progress in Cardiovascular Diseases*, *57*(4), 368–374. https://doi.org/10.1016/j.pcad.2014.09.010

Kok, G., Gottlieb, N. H., Commers, M., & Smerecnik, C. (2008). The ecological approach in health promotion programs: A decade later. *American Journal of Health Promotion*, *22*(6), 437–442. https://doi.org/10.4278/ajhp.22.6.437

Kokko, S. (2014). Sports clubs as settings for health promotion: Fundamentals and an overview to research. *Scandinavian Journal of Public Health*, *42*(15, Suppl.), S60–S65. https://doi.org/10.1177/1403494814545105

Krug, S., Jordan, S., Mensink, G. B. M., Müters, S., Finger, J., & Lampert, T. (2013). Körperliche Aktivität : Ergebnisse der Studie zur Gesundheit Erwachsener in Deutschland (DEGS1) [Physical activity: Results of the German Health Interview and Examination Survey for Adults (DEGS1)]. *Bundesgesundheitsblatt, Gesundheitsforschung, Gesundheitsschutz*, *56*, 765–771. https://doi.org/10.1007/s00103-012-1661-6

Lasswell, H. D. (1956). *The decision process: Seven categories of functional analysis*. University of Maryland Press.

Latimer-Cheung, A. E., Rhodes, R. E., Kho, M. E., Tomasone, J. R., Gainforth, H. L., Kowalski, K., Nasuti, G., Perrier, M.-J., & Duggan, M. (2013). Evidence-informed recommendations for constructing and disseminating messages supplementing the new Canadian Physical Activity Guidelines. *BMC Public Health*, *13*, Article 419. https://doi.org/10.1186/1471-2458-13-419

Leone, L., & Pesce, C. (2017). From delivery to adoption of physical activity guidelines: Realist synthesis. *International Journal of Environmental Research and Public Health*, *14*(10), Article 1193. https://doi.org/10.3390/ijerph14101193

Lozano-Sufrategui, L., Pringle, A., Zwolinsky, S., & Drew, K. J. (2020). Professional football clubs' involvement in health promotion in Spain: An audit of current practices. *Health Promotion International*, *35*(5), 994–1004. https://doi.org/10.1093/heapro/daz097

Maddock, J. E., & Kellstedt, D. (2020). Initial mass media coverage of the 2nd edition of the physical activity guidelines for Americans. *Preventive Medicine Reports*, *19*, Article 101157. https://doi.org/10.1016/j.pmedr.2020.101157

Mayring, P. (2000). Qualitative content analysis. *Forum: Qualitative Social Research*, *1*(2), Article 20. https://www.qualitative-research.net/index.php/fqs/article/view/1089/2386

McLeroy, K. (2006). Thinking of Systems. *American Journal of Public Health*, *96*(3), 402. https://doi.org/10.2105/AJPH.2005.084459

Muellmann, S., Steenbock, B., Cocker, K. de, Craemer, M. de, Hayes, C., O'Shea, M. P., Horodyska, K., Bell, J., Luszczynska, A., Roos, G., Langøien, L. J., Rugseth, G., Terragni, L., Bourdeaudhuij, I. de, Brug, J., &

Pischke, C. R. (2017). Views of policy makers and health promotion professionals on factors facilitating implementation and maintenance of interventions and policies promoting physical activity and healthy eating: Results of the DEDIPAC project. *BMC Public Health*, *17*(1), Article 932. https://doi.org/10.1186/s12889-017-4929-9

Piercy, K. L., Dorn, J. M., Fulton, J. E., Janz, K. F., Lee, S. M., McKinnon, R. A., Pate, R. R., Pfeiffer, K. A., Young, D. R., Troiano, R. P., & Lavizzo-Mourey, R. (2015). Opportunities for public health to increase physical activity among youths. *American Journal of Public Health*, *105*(3), 421–426. https://doi.org/10.2105/AJPH.2014.302325

Pollack, K. M., Schmid, T. L., Wilson, A. L., & Schulman, E. (2016). Advancing translation and dissemination research and practice through the Physical Activity Policy Research Network Plus. *Environment and Behavior*, *48*(1), 266–272. https://doi.org/10.1177/0013916515616990

Provan, K. G., & Kenis, P. (2007). Modes of network governance: Structure, management, and effectiveness. *Journal of Public Administration Research and Theory*, *18*(2), 229–252. https://doi.org/10.1093/jopart/mum015

Provan, K. G., & Milward, H. B. (2001). Do networks really work? A framework for evaluating public-sector organizational networks. *Public Administration Review*, *61*(4), 414–423. http://www.jstor.org/stable/977503

Reiner, M., Niermann, C., Jekauc, D., & Woll, A. (2013). Long-term health benefits of physical activity - A systematic review of longitudinal studies. *BMC Public Health*, *13*(1), Article 813. https://doi.org/10.1186/1471-2458-13-813

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press. http://www.loc.gov/catdir/bios/simon052/2003049022.html

Rütten, A., Abu-Omar, K., Messing, S., Weege, M., Pfeifer, K., Geidl, W., & Hartung, V. (2018). How can the impact of national recommendations for physical activity be increased? Experiences from Germany. *Health Research Policy and Systems*, *16*, Article 121. https://doi.org/10.1186/s12961-018-0396-8

Rütten, A., & Pfeifer, K. (Eds.). (2016). *Nationale Empfehlungen für Bewegung und Bewegungsförderung*. FAU Erlangen-Nürnberg.

Sallis, J. F., Cervero, R. B., Ascher, W., Henderson, K. A., Kraft, M. K., & Kerr, J. (2006). An ecological approach to creating active living communities. *Annual*

Review of Public Health, *27*, 297–322. https://doi.org/10.1146/annurev.publhealth.27.021405.102100

Schmidt, S. C. E., Anedda, B., Burchartz, A., Oriwol, D., Kolb, S., Wäsche, H., Niessner, C., & Woll, A. (2020). The physical activity of children and adolescents in Germany 2003-2017: The MoMo-study. *PloS One*, *15*(7), Article e0236117. https://doi.org/10.1371/journal.pone.0236117

Simons-Morton, D. G., Simons-Morton, B. G., Parcel, G. S., & Bunker, J. F. (1988). Influencing personal and environmental conditions for community health: A multilevel intervention model. *Family & Community Health*, *11*(2), 25–35. https://doi.org/10.1097/00003727-198808000-00006

Skille, E. Å. (2010). Competitiveness and health: The work of sport clubs as seen by sport clubs representatives - A Norwegian case study. *International Review for the Sociology of Sport*, *45*(1), 73–85. https://doi.org/10.1177/1012690209352395

Spence, J. C., Faulkner, G., Bradstreet, C. C., Duggan, M., & Tremblay, M. S. (2015). Active Canada 20/20: A physical activity plan for Canada. *Canadian Journal of Public Health / Revue Canadienne De Santé Publique*, *106*(8), e470-e473. http://www.jstor.org/stable/90006153

Trochim, W. M., Cabrera, D. A., Milstein, B., Gallagher, R. S., & Leischow, S. J. (2006). Practical challenges of systems thinking and modeling in public health. *American Journal of Public Health*, *96*(3), 538–546. https://doi.org/10.2105/AJPH.2005.066001

van Rinsum, C. E., Gerards, S., Rutten, G. M., van de Goor, I., & Kremers, S. (2017). Health brokers: How can they help deal with the wickedness of public health problems? *BioMed Research International*, *2017*, Article 1979153. https://doi.org/10.1155/2017/1979153

Vuori, I. M., Lavie, C. J., & Blair, S. N. (2013). Physical activity promotion in the health care system. *Mayo Clinic Proceedings*, *88*(12), 1446–1461. https://doi.org/10.1016/j.mayocp.2013.08.020

Wäsche, H., Peters, S., Appelles, L., & Woll, A. (2018). Bewegungsförderung in Deutschland: Akteure, Strukturen und Netzwerkentwicklung. *Bewegungstherapie & Gesundheitssport*, *34*(6), 257–273. https://doi.org/10.1055/a-0739-9857

Williamson, K., & Johanson, G. (Eds.). (2018). *Research Methods: Information, systems, and contexts* (2nd ed.). Chandos Publishing.

Woolf, S. H., Purnell, J. Q., Simon, S. M., Zimmerman, E. B., Camberos, G. J., Haley, A., & Fields, R. P. (2015). Translating evidence into population health improvement: Strategies and barriers. *Annual Review of Public Health*, *36*, 463–482. https://doi.org/10.1146/annurev-publhealth-082214-110901

World Health Organization. (2004). *Global strategy on diet, physical activity, and health*. World Health Organization. https://www.who.int/publications/i/item/9241592222

World Health Organization. (2018). *More active people for a healthier world: Global action plan on physical activity 2018-2030*. World Health Organization. https://www.who.int/publications/i/item/9789241514187

World Health Organization. (2020). *WHO guidelines on physical activity and sedentary behaviour*. World Health Organization. https://www.who.int/publications/i/item/9789240015128

Additional file 1 - Recommendations for action

The aim of this study was to develop recommendations for action on how a national dissemination strategy of physical activity (PA) recommendations including relevant change agents should be designed by considering the *change agents' perceived relevance and knowledge* concerning PA and PA promotion and their *needs* with regard to the implementation of the German National Recommendations for Physical Activity and Physical Activity Promotion (NRPP) in specific settings.

Based on the study findings, the following recommendations can be made:

- Strengthening the political significance of PA promotion by establishing a national institute for PA that centrally coordinates and is responsible for disseminating the NRPP.
- Changing awareness regarding the importance of PA in the population as a whole and in individual areas of society (politics, education, health care, workplace) through a clearly developed communication concept including media campaigns and health education.
- Improving the cooperation of relevant change agents at the national, state, and community level through the nomination of central coordinating administrative units (network governance).

- Appealing to the personal responsibility of change agents to engage in NRPP implementation in their respective setting and organization.
- Focusing on the economic, social, and ecological relevance of PA promotion to create incentives for change agents not involved in health (e.g., urban planning departments, sporting goods manufacturers) to implement the NRPP.
- Improving the cooperation between science and practice through transdisciplinary approaches to translate the scientific findings of the NRPP into political implementation strategies, medical treatment strategies, and specific PA promoting measures useful in practice.
- Communication of the NRPP to relevant change agents to enable a systematic approach to PA promotion. Compact online availability of the NRPP.
- Development and communication of methodological kits, working aids, and practical instruments that support change agents in a scientifically based and efficient implementation of the NRPP.
- More financial incentives for individuals, physicians, health insurance companies, employers, and sports clubs to become involved in PA promotion.
- Integration of PA promotion in the vocational training of teachers, kindergarten teachers, and social education workers. In particular, adequate qualification of teaching staff concerning high-quality and multi-faceted physical education, in which health skills are taught.
- Structural anchoring of PA promotion in educational institutions through PA offers and PA breaks.
- Establishment of a PA-friendly organizational culture, PA-promoting structures, and more flexible working hours by employers.
- Increase of financial, time, personnel, and spatial resources in educational institutions, workplace settings, and within the health sector.
- Availability of more public space for leisure sports and everyday PA through a change in planning specifications of urban planning departments.
- More attractive PA programs for all age groups provided by sports clubs and development of a broader range of easily accessible public and digital PA programs.

Chapter 3: Physical activity promotion in an urban district

Paper II: Physical activity promotion in an urban district: Analyzing the mechanisms of interorganizational cooperation

Slightly modified version of the published paper

Wäsche, H.*, Wolbring, L.*, & Woll, A. (2021). Physical activity promotion in an urban district: Analyzing the mechanisms of interorganizational cooperation. *PLOS ONE*, *16*(11), Article e0260053. https://doi.org/10.1371/journal.pone.0260053

*Authors contributed equally to this work

Abstract

Past research has identified the importance of cooperation among community-based organizations from different sectors to address public health problems such as insufficient physical activity. However, little is known about how and why interorganizational cooperation occurs. The present study sought to analyze the structure and emergent patterns of interorganizational cooperation within a network promoting physical activity based in an urban district neighborhood of a city in Southwestern Germany. Survey data on cooperative relations among 61 network organizations and organizational attributes (e.g., possession of sport facilities) were collected. Social network analysis was applied to examine network properties and exponential random graph models were estimated to test hypotheses concerning mechanisms and conditions of cooperative tie formation. The results show that the network of cooperation is sparse but characterized by a tendency for cooperation to occur in triangular structures. Other significant mechanisms of cooperative tie formation are preferential attachment, with the community department for education and sports being the most central network actor, and heterophily regarding the cooperation of organizations from different sectors. This study provides valid and reliable findings on conditions of network formation and significant mechanisms of interorganizational cooperation in the field of physical activity promotion. Knowledge about these mechanisms can help to manage networks effectively and efficiently and reveal potentials for improvement and intensification of interorganizational cooperation in both the present and other research areas of health promotion.

Introduction

Insufficient physical activity (PA) is a leading risk factor for global mortality (Hamer et al., 2017). The results of numerous longitudinal studies show that lack of PA is associated with the development of non-communicable diseases, such as coronary heart disease, diabetes mellitus type 2, dementia, and some mental disorders (Reiner et al., 2013). Globally, about one in four adults is not active enough with this number being even higher in high-income countries (Guthold et al., 2018). The World Health Organization (2018) recommends several policies to enhance PA, which include among others to create active environments with easily accessible places, opportunities, and programs that support an engagement in regular PA.

In this context, communities and their neighborhoods play a crucial role in providing the physical and social environment for people living there. As Bauman et al. (2012) found out, the existence of organized sport structures and recreation facilities in the immediate surroundings is of great significance when it comes to PA participation. This goes hand in hand with the approach that health extends beyond the individual actions of a single person and depends on structural developments and environmental conditions, which also include the organizational level (McLeroy et al., 1988). Thus, physical activity promotion (PAP) is a crucial challenge of sustainable urban development since "a different balance of environmental factors may be required to better support participation in community-oriented sport, recreation and physically active leisure" (Rowe et al., 2013, p. 373).

Past research in the field of sports, recreation, and health has identified the increasing importance of partnerships, linkages, and cooperation of community-based organizations from different sectors to solve public health problems such as insufficient PA levels that cannot be tackled by one single agency (Bevc et al., 2015b; Loitz et al., 2017; Provan et al., 2005; Thibault et al., 2010; Valente et al., 2007; Wolbring et al., 2021). Interorganizational community networks can create synergy effects and reduce duplication efforts by exchanging resources, information, and expertise of involved actors. This, in turn, may improve the efficiency and enhance the capacity of a community to bring different players together to solve challenging community problems and generate greater public awareness (Agranoff, 2003; Butterfoss et al., 1996; Hambrick et al., 2019; Provan & Milward, 2001).

Social network analysis (SNA) is a helpful tool to understand which actors are involved in a network, to learn how the network is structured, and to find out which new relations might be highly valuable to develop (Contandriopoulos et al., 2016; Provan et al., 2005). In addition, it can predict cooperation and effectiveness in organizations as well as potentials for improvement (Buchthal et al., 2013; Schoen et al., 2014).

Previous studies have analyzed the structure of these networks but did rarely examine the determinants of network emergence (Brownson et al., 2010; Meisel et al., 2014; Parra et al., 2011). To understand the key aspects, conditions, and causes of cooperative tie formation will help to derive measures on how to develop and manage networks aiming at PAP.

Therefore, the purpose of the present study is to investigate the structure and emergent patterns of cooperation within an interorganizational PAP network based in an urban district of a city in Southern Germany. We aim to examine not only the quality and structure of cooperation but also the types of structural (network-related) and attributive (actor-related) effects that proved to be significant for the formation of interorganizational cooperative ties. Based on this, findings on the development and governance of such networks should be derived.

Network perspective in public health research

Network research is based on a relational perspective, which means that interesting phenomena are explained by underlying structures. Individuals or organizations are embedded in this structure and do not act in isolation but in mutual dependence. Thus, it is not the individual social actors that are the unit of investigation but their relationships to each other (Borgatti et al., 2013; Emirbayer, 1997; Kadushin, 2012; Wäsche et al., 2017).

SNA has its origins in the 1930s, when it was first applied in sociology and psychology (Moreno, 1934). Nowadays, network analysis is a largely established research approach that is used in disciplines, such as political science, organizational theory, computer science, mathematics, as well as public health (Borgatti et al., 2009; Luke & Harris, 2007). It has been employed in nearly every area of (public) health research, including adolescent risk taking (Hall & Valente, 2007), bullying (Mouttapa et al., 2004), community-based participatory research (Valente et al., 2010), obesity and PA (de la Haye et al., 2010), as well as community coalitions and interorganizational relations

(Barnes et al., 2010; Brownson et al., 2010). Luke and Harris (2007) distinguish between three categories of public health networks: Transmission networks, social networks and organizational networks. The latter are seen as one of the most useful public health approaches to share resources and knowledge in order to improve population health (Bevc et al., 2015b). Organizational networks investigate the ties and interactions between agencies or organizations by taking a systems approach (Luke & Harris, 2007). The underlying idea is that public health problems are very complex and multifaceted, however, the public means to solve these problems are generally scarce. Thus, cooperation of public and private organizations from various sectors is important to unite different core competencies and resources in order to develop solutions together in a multisystemic approach. Especially cross-sectoral cooperation beyond the health sector is needed to tackle these problems by joining different perspectives (Bevc et al., 2015b; Varda et al., 2008). To address public health problems most effectively, it is particularly promising to foster networks on the community level as this is the setting where people live, work, learn, and exercise (Lasker & Weiss, 2003; Mays & Scutchfield, 2010; Sallis et al., 2006; Valente et al., 2007; Varda et al., 2008).

It is assumed that the more ties are realized within interorganizational networks, that is, the more working relationships characterized by trust and mutual support are established and the greater the diversity of available resources, the higher the probability that positive results will be achieved (Retrum et al., 2013).

Based on the structural properties and configurations of interorganizational networks, conclusions can be drawn for network governance, which is essential to manage a network effectively. Three different forms of networks governance can be distinguished (Provan & Kenis, 2007), which also apply to the field of sports and PA (Wäsche & Gerke, 2019): Firstly, there are participant-governed networks, which represent a highly decentralized form where the network is completely governed by the organizations comprising it. The second type are lead organization-governed networks, describing highly centralized networks which are governed by a single network member. Finally, there are network administration organization-governed (NAO) networks, which also represent a centralized form, however, the leading role is taken by an external organization that is not part of the network. The effectiveness of the different types of network governance is determined by four predictors: distribution of trust throughout the network (density), number of network participants (size), network goal consensus,

and the need for network-level competencies such as coordinating and task-specific skills.

Interorganizational networks to promote physical activity

Several studies have examined interorganizational PAP networks revealing mixed results concerning network properties and structure (Timm et al., 2021). This can be attributed to the fact that types of network organizations varied significantly, as did the administrative levels (community, regional, national) at which they operated. In addition, previous studies differ both in terms of the types of cooperation considered and the degree of network formalization, i.e. formally established vs. organically grown networks.

While there are some studies that examine interorganizational PAP networks descriptively (An, Khan, et al., 2017; An, Loehmer, et al., 2017; Barnes et al., 2010; Buchthal et al., 2013; Loitz et al., 2017; McCullough et al., 2016; Yessis et al., 2013), there are only few studies using statistical modeling and explanatory network analysis to identify relevant patterns of network emergence (Brownson et al., 2010; Meisel et al., 2014; Parra et al., 2011). Results concerning cooperative tie formation are also heterogeneous and strongly depend on the types of organizations involved, the aim of the network, and the conditions of the specific setting and environment, highlighting the need for further analysis.

Based on the idea that the relationships between community-based organizations offering and promoting PA are of decisive importance for the design of urban space and the availability of PA programs, the following study uses SNA to capture, visualize, and evaluate how interorganizational cooperation is structured in a local network promoting PA. Moreover, it aims to reveal underlying mechanisms and conditions of cooperation. Consequently, not only network properties were examined but also several hypotheses concerning the emergence of cooperative ties between the network organizations were tested.

The hypotheses include both endogenous (structural) network effects based on frequently detected configurations of cooperation in self-organizing networks (Lusher et al., 2013) and exogenous (attributive) effects related to organizational characteristics which might also predict tie formation. The following hypotheses were derived.

Centralization is an effect that can often be observed in networks (Barabasi, 1999; Hennig et al., 2012). It occurs when network ties are unequally distributed so that a few actors have more ties than others. This results in a preferential attachment effect, where these few actors take a powerful role within the network and have a great influence on network processes. As a result, more and more actors tend to form a connection to the popular actors making them even more powerful. As this effect is frequently observed in interorganizational networks, the relevance of preferential attachment in PAP networks was of interest. Therefore, this study investigated if PAP organizations tend to form cooperative relationships to popular organizations.

Hypothesis 1: PAP organizations form more cooperative ties to popular organizations.

Another phenomenon often observed in networks is the closure of triangles representing an effect of network closure (Robins et al., 2012). This effect occurs when a path from actor A to actor B to actor C is closed by a tie from actor C to actor A. The closure of triangles can be seen as an expression of the propensity of actors to act in group-like patterns based on reciprocal support and social trust, which is a significant characteristic of interorganizational networks (Powell, 1990). The closure from A, B, and C to a closed triangle is an indication that a cooperative relation from C to A (or vice versa) has emerged whose reliability has been approved by a shared neighbor, namely B. This effect is also known as transitivity. It was hypothesized that PAP organizations were more likely to form triplets of cooperation.

Hypothesis 2: PAP organizations form triplets of cooperation.

Homophily refers to the principle that social actors tend to form ties to actors that are similar to them rather than to those that are not similar to them. However, in the present network, the opposite mechanism of working across sector boundaries in multisectoral clusters could play a more important role concerning the formation of ties, as advocated by previous studies (Bevc et al., 2015a; Meisel et al., 2014). A possible explanation for this is provided by resource-dependence theory, which assumes that organizations form heterophil ties to other actors to get access to more diverse information or resources than that available through homogenous ties (Pfeffer & Salancik, 1978). Consequently, this also allows for capacity building and the elimination of structural holes as resources are made accessible to others (Burt, 1992; Hambrick et al., 2019). Therefore, it was hypothesized that PAP organizations of a dissimilar type (from

different sectors) will develop more cooperative ties among each other, indicating a heterophily effect.

Hypothesis 3: PAP organizations from different sectors develop more cooperative ties among each other.

Not only heterophily might lead to cooperative ties between organizations but also a higher cooperation activity of organizations based on their specific attributes could play an important role. Some PAP organizations might have their own facilities to carry out their sports activities while others do not. Organizations that own a sports facility could therefore show a higher activity in creating cooperative ties as other organizations that do not have a sports facility are dependent on them. Thus, we tested whether the possession of sports facilities results in more cooperative ties.

Hypothesis 4: PAP organizations which own a sport facility show a higher activity in developing cooperative ties.

Methods

Sampling and procedure

The current study was carried out in the context of an urban real-world laboratory (Waitz et al., 2017; Wäsche et al., 2021). The setting was a district of the city of Karlsruhe in Southwestern Germany. The district has about 22,000 inhabitants, 42.2 % of whom are female and 57.8 % male. It is considered as a mature, typically European district that can serve as a model for other urban living spaces in Europe. To locate eligible participants of the network, a systematic search for sports and PA offerings was carried out. Organizations were included if they either owned a sports facility or provided sports and PA programs in the corresponding district. Based on a broad concept of sports, not only traditional and commercial sports facilities and providers, such as sports clubs and fitness centers, but also institutions offering sports and PA programs, such as schools and old people's homes, were included. In addition, organizations which assumed superordinate, administrative and advisory functions concerning sports and PA in the city district were taken into account. In this particular case, the location of the latter organizations did not necessarily have to be in the city district of interest.

72 potentially relevant organizations were identified and invited to participate in the study. Data were collected through a web-based questionnaire which was sent to the organizations via e-mail. Different questionnaires were created for each of the following organizational types: Sports clubs, schools, kindergartens/daycare, sports administration and other sports providers (e.g., private sports providers, religious institutions, care facilities).

The study was conducted in accordance with the Declaration of Helsinki and was approved by the institutional review board of the Institute of Sports and Sports Science, Karlsruhe, Germany. All participants gave their written informed consent before participation. 39 organizations (54.2 %) participated in the survey and provided usable data. 33 organizations (45.8 %) did not participate despite multiple reminders (via e-mail and phone) (41.7 %) or due to incorrect or missing information (4.2 %). The percentages in parentheses all refer to the 72 identified organizations that were invited to participate in the survey. If an organization had indicated a cooperation with other organizations that had not taken part in the survey, this relationship was symmetrized. Since binary data distinguishing only whether a relationship exists or not and cooperative relations are inherently reciprocal, any cooperative tie from one institution to another could always be regarded as undirected and symmetrical (Erlhofer, 2010). Through symmetrization, relationships of a total of 22 organizations that did not participate in the survey themselves could be reconstructed, which resulted in a network consisting of 61 organizations (84,7 % of invited network actors).

Measures

Organizations were asked whether they possessed a sports facility in the district of interest. If so, they were supposed to indicate the location, type, and other characteristics of the sports facility.

To survey the cooperative ties between the organizations, participants received a list of all identified organizations and were asked with whom they cooperate concerning sports and PA offerings in the corresponding city district. They could name up to ten cooperation partners and had to indicate at least one of the four following types of cooperation for each partner: exchange of information, exchange of personnel, cooperation in the provision of sports and PA programs, and use of sports facilities. Please

also refer to S1 Survey items for detailed information on the questionnaire used for data collection.

Data analysis

For further analysis, the organizations were assigned to three different sectors: the public sector (e.g., schools, universities, health insurances, community departments, public kindergartens), the private sector (e.g., for-profit sports providers and practices), and the non-profit sector (e.g., sports clubs). As in previous studies (Brownson et al., 2010), the different types of cooperative ties were joined into one matric and the network was dichotomized, where 0 indicated no tie and 1 indicated the existence of any type of cooperation (exchange of information, exchange of personnel, cooperation in the provision of sports and PA programs, cooperation in use of sports facilities). Thus, when cooperation is referred to in the following, all types of cooperative ties are considered together.

Descriptive network properties were analyzed with the software package Ucinet (version 6.721) (Borgatti et al., 2002) and corresponding network visualizations were created with the software package Visone (version 2.19) (Brandes & Wagner, 2011). On the node level, degree centrality (CD), betweenness centrality (CB), and eigenvector centrality (CE) scores were examined. While CD refers to the actors' number of direct ties to other actors, CB can provide insights into how often an organization lies on the shortest path between two other organizations. The higher the CB of an actor, the more control he has over the communication and flow of information within the network. Furthermore, CB can identify actors who could assume a coordinating role concerning network processes (Freeman, 1978). CE measures the importance of an actor by also taking into account the centrality of the nodes the actor is connected to. On the network level, average degree (average number of cooperative ties), density (ratio of realized ties to maximum possible number of ties), the global clustering coefficient (number of closed triangles divided by the total number of closed and open triangles), average distance (average shortest path between a set of two organizations), and degree centralization (extent to which all ties of the network are organized around a few central organizations) were analyzed.

To test the hypotheses concerning mechanisms and conditions of cooperative tie formation, exponential random graph models (ERGMs) were estimated. They offer a

suitable solution to analyze how and why social networks emerge as these models allow predictions about the likelihood and rules for the occurrence of cooperative ties between actors based on organization and network properties (Robins, Pattison, et al., 2007; Robins, Snijders, et al., 2007). ERGMs take into account the interdependence of observations, i.e. that one relationship within the network also influences the other relationships in the same network (Lusher et al., 2013). It is assumed that social networks are composed of smaller micro-configurations, such as triangles or stars, through which the network pattern can be described. Supposed that social networks are subject to principles of self-organization and interdependence of tie formation, ERGMs allow inferences about whether specific micro-configurations are more frequently observed in the network than might be expected by chance. This can then be used to identify social processes that could lead to these structural characteristics. Besides structural micro-configurations, called endogenous network effects, ERGMs can also be used to analyze exogenous network effects, that is, specific attributes of the actors and their influence on tie formation. The results indicate which of the configurations occur more often or less often (positive or negative value for each parameter) than expected based on the existing conditions (Robins, Pattison, et al., 2007).

Mathematically, “this approach models the probability that a relation exists […] as a linear function of predictors” (Goodreau et al., 2009, p. 105):

$$P(X) = \frac{1}{\kappa(\theta)} \exp\left(\sum_i \theta_i s_i(X)\right)$$

ERGMs explain the global pattern of an observed network, represented by X in the formula, as a function of statistical parameters θ_i and micro-structures $s_i(X)$. The probability of the investigated network X is expressed as a function of the local configurations $s_i(X)$. Since this involves a probability distribution, the formula contains the normalizing quantity $\kappa(\theta)$ so that the probability of the investigated network ranges from 0 to 1. Similar to regression, X represents the dependent variable, the local configurations $s_i(X)$ represent the predictor variables, and the respective parameters θ_i indicate how important $s_i(X)$ is in determining $P(X)$. The micro-structures or predictor variables $s_i(X)$ can both represent endogenous or exogenous network effects. As there are many distinctive local configurations $s_i(X)$ that can determine the structure of X, researchers make a selection based on the hypotheses they wish to investigate. The statistical

parameter θ_i allows, by simultaneously considering other effects in the model, inferences about whether the specific micro-configurations $s_i(X)$ are more frequently observed in X than might be expected by chance. So, if we observe a higher quantity of local micros-configurations $s_i(X)$ in X than would be expected when the ties were randomly formed, we have evidence of the prominence of $s_i(X)$ to account for the global structure of the network X. Therefore, if a parameter value associated to $s_i(X)$ is positive (negative), we can assume that these configurations can be observed more often (less often) in the network than would be expected by chance, which provides evidence for (against) the process associated with such configurations (Robins, Pattison, et al., 2007).

In other words, the existence of a relation within a network can be predicted from different variables, which represent specific configurations the tie is involved in. The positive or negative value of an estimated parameter indicates the significance of this specific configuration for the emergence of a tie.

Markov chain Monte Carlo maximum likelihood methods were used to estimate the parameters for each configuration. Two models were estimated: The first model included only structural (endogenous) network effects. In reference to the previously established hypotheses, alternating stars, indicating network centralization, and alternating triangles, indicating network closure, were estimated as structural parameters. In the second model (full model), attribute-related (exogenous) network effects were added. The following two attribute parameters were included: Mismatch (heterophily effect) refers to the cooperative ties between the three organizational sectors and activity refers to the hypothesized higher cooperative activity of organizations that possess a sports facility. Included endogenous and exogenous parameters and their specific graph configurations are displayed in Figure 1. ERGMs have been estimated with the software package Pnet (version 1.0) (Wang et al., 2009).

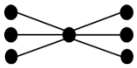
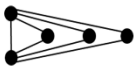
Parameter	Configuration	Description
Edges		Models the tendency to form ties.
Activity spread (alternating stars)		Models centralization of preferential attachment.
Multiple triangulation (alternating triangles)		Models the formation of triplets, indicating network closure or transitivity.
Heterophily (interaction / mismatch)		Models the tendency for the formation of ties between actors with a different attribute.
Activity		Models the tendency of an actor with a specific attribute to form ties.

Figure 1: Description of included ERGM parameters

Results

Descriptive analysis

The analyzed network consisted of 61 actors (see Table 1 for the complete list of actors). Most of the organizations were non-profit oriented (50.8 %), 31.2 % belonged to the public sector and 18 % to the private sector. 60.7 % of the organizations owned a sports facility, correspondingly 39.3 % did not. 50 of the 61 (82.0 %) actors had realized cooperative ties, whereas eleven organizations were isolated, most of which were organizations from the private sector or kindergartens (see Figure 2). Overall, there were 74 edges in the analyzed network. Since cooperation is undirected, the network consisted of 148 ties, resulting in a density of 0.04. Thus, only 4 % of possible ties had been realized. The average degree was 2.4 (SD = 3.6). Both density and average degree indicate that the network is relatively sparse. The global clustering coefficient was 0.21, pointing towards some tendency that cooperation in the PAP network occurs in triangular structures. The average distance was 2.7, which means that if an organization wants to communicate with another organization with which it is not directly connected, on average, almost two organizations have to act as bridging agents.

Table 1: List of network actors

Id	Name	Id	Name
1	Private fitness center	32	Non-profit kindergarten IV
2	Provider of educational sports and exercise programs	33	Public kindergarten
3	Health insurance I	34	Non-profit kindergarten V
4	Private health center	35	Health insurance II
5	Yoga school	36	Community department for horticulture
6	Personal training	37	University institute for sports I
7	Cultural institution for children and young people	38	Community department for education and sports
8	Physiotherapy practice I	39	Union of local sports clubs
9	Public after-school care center	40	Association of local sports clubs
10	Tai Chi and Qigong school	41	Health insurance III
11	Religious institution I	42	Local sports club VI
12	Religious institution II	43	Local soccer club II
13	Public old people’s home	44	Local sports club VII
14	Educational outdoor park	45	University institute for sports II
15	Local sports club I	46	Administration of local swimming centers
16	Local sports club II	47	Local sports club VIII
17	Local sports club III	48	Local sports club IX
18	Local soccer club I	49	Scout tribe
19	Local sports club IV	50	Physiotherapy practice II
20	Dancing club	51	Local sports club X
21	Tennis club	52	Midwife practice
22	Local sports club V	53	Public school V
23	Public school I	54	Karate school

24	Public school II	55	Community social and youth authority
25	Public school III	56	Local soccer club III
26	Public school IV	57	Local sports club XI
27	Private kindergarten I	58	City youth committee
28	Non-profit kindergarten I	59	Health insurance IV
29	Private kindergarten II	60	Provider of educational outdoor programs
30	Non-profit kindergarten II	61	Provider of educational circus programs
31	Non-profit kindergarten III		

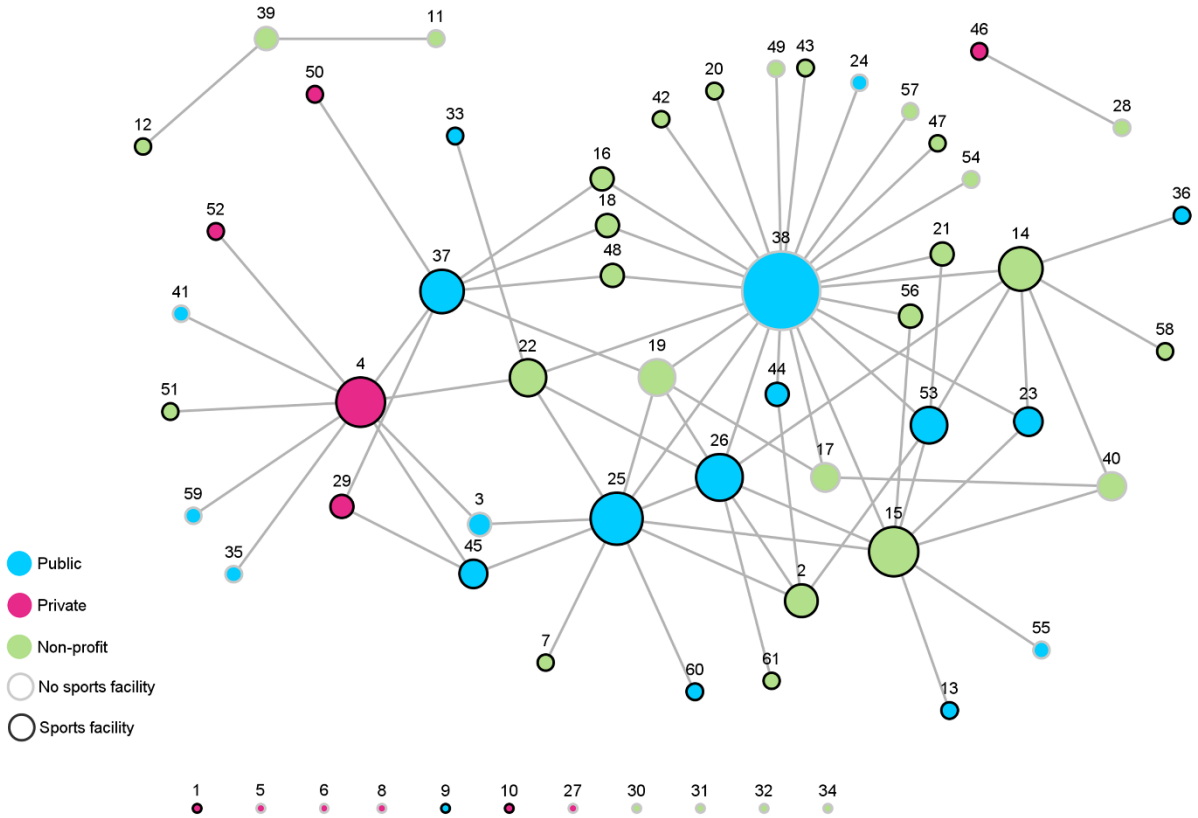


Figure 2: Visualization of the PAP network of cooperation (n = 61). Ties between nodes indicate cooperation, node color represents sector affiliation, node boarder color represents possession of sports facility, node size represents degree centrality score (number of collaborative ties to other organizations)

The number of ties as well as the normalized centrality scores for degree, betweenness, and eigenvector of the 15 highest scoring actors are listed in Table 2. Figure 3 shows the different positions held by the organizations concerning the number of ties, visualized using a centrality layout.

Table 2: Number of ties and normalized degree, betweenness, and eigenvector centrality scores of the 15 highest scoring organizations

Id	No. of ties	Degree	Betweenness	Eigenvector
38	23	0.38	0.31	0.76
25	10	0.17	0.10	0.43
4	9	0.15	0.12	0.11
15	9	0.15	0.06	0.42
26	8	0.13	0.05	0.44
14	7	0.12	0.05	0.31
37	7	0.12	0.06	0.14
19	5	0.08	0.02	0.31
22	5	0.08	0.10	0.28
53	5	0.08	0.01	0.29
2	4	0.07	0.00	0.21
17	3	0.05	0.00	0.19
23	3	0.05	0.00	0.24
40	3	0.05	0.00	0.15
45	3	0.05	0.02	0.09

With regard to CD, the community department for education and sports (actor 38) had the highest number of ties to other organizations and therefore represents the most central actor with respect to popularity followed by the public school III (actor 25), the local sports club I (actor 15), a private health center (actor 4), and the public school IV (actor 26). The large difference in CD between the most central and the second most central actor illustrates the important position that the community department for education and sports occupies. This is also evident in the network visualization (Figure 2). The degree centralization in relation to the whole network is 0.36, illustrating the

difference between the CD of the community department for education and sports and all other actors of the network.

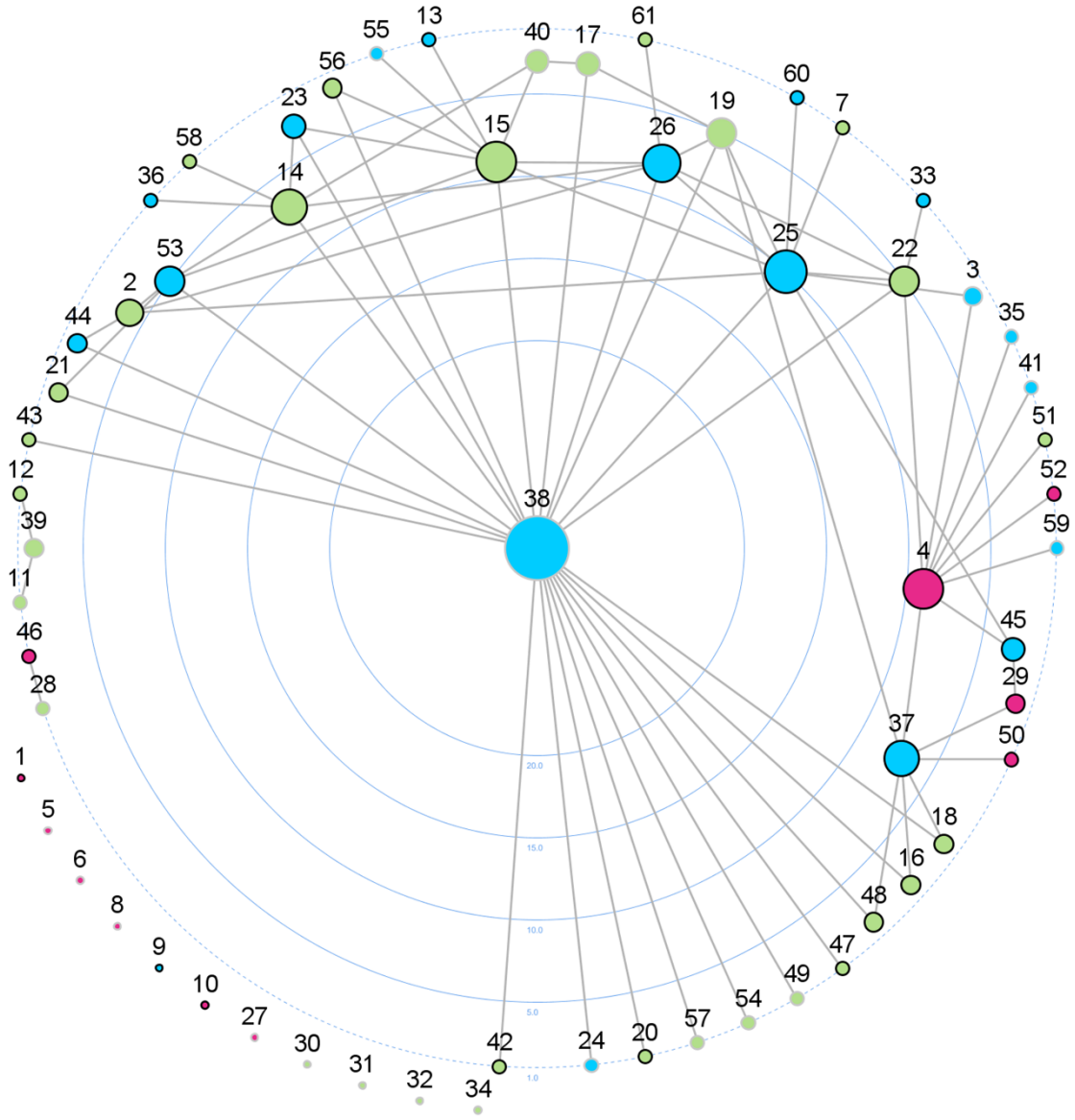


Figure 3: Degree centrality visualization (number of ties) of the PAP network of cooperation (*n* = 61)

The ten highest scoring organizations concerning CB are nearly the same as for CD, only the ranking order is different. The organization with the highest CB is again the community department for education and sports (actor 38), but the private health center (actor 4) moved from the third (CD) to the second position. The third most central position concerning CB is held by the local sports club V (actor 22), followed by the public school III (actor 25), which moved from second (CD) to the fourth position. The

local sports club I (actor 15) is the fifth most central actor regarding CB, holding the fourth position in the CD ranking. Only 22 of all organizations held a CB position, while 39 organizations had a CB score of 0 und thus had no influence on communication processes or flow of information.

Regarding CE, almost the same organizations are among the most central but the order is again slightly different. The community department for education and sports is still the most central actor concerning CE. However, it is noticeable that the public school IV (actor 26), which ranks fifth in CD and eighth in CB, is the organization with the second highest CE.

Exponential random graph models

The results of the two ERGMs are displayed in Table 3. In model 1, two of the three parameter estimates were significant. The edges parameter was negative suggesting that fewer cooperative ties are realized in the network than would be expected by chance, which points to a relatively sparse network. The positive estimate for centralization provided evidence for a preferential attachment effect implying a tendency for cooperation to revolve around a few central actors (hypothesis 1). The parameter for multiple triangulation was not significant in the first model (hypothesis 2). When adding the exogenous network effects (model 2), the negative edges and positive centralization parameter were still significant. Moreover, the second model provided evidence for multiple triangulation (hypothesis 2). Concerning the attribute-related effects, a positive heterophily effect for organizations from different sectors developing more cooperative ties among each other was found (hypothesis 3). The activity effect for organizations that own a sports facility was not significant (hypothesis 4). In summary, hypothesis 1 can be confirmed as a preferential attachment effect could be observed. Hypothesis 2 can also be confirmed, since a multiple triangulation effect was found in model 2. Organizations from different sectors seem to cooperate more frequently, thus hypothesis 3 can be confirmed as well. However, hypothesis 4 must be rejected since organizations that own a sports facility did not show a higher cooperative activity.

Goodness-of-fit-statistics showed satisfactory model fit for the final models.

Table 3: ERGM parameter estimates for the PAP network of cooperation

	Model 1		Model 2	
Parameter	**Estimate**	***SE***	**Estimate**	***SE***
Cooperative ties (edges)	-5.34*	0.29	-5.90*	0.42
Structural predictors				
Centralization (preferential attachment)	0.71*	0.13	0.72*	0.14
Multiple triangulation (closure)	0.28	0.15	0.27*	0.13
Attribute predictors				
„Sector“ heterophily			0.55*	0.26
„Sports facility“ activity			0.15	0.13

SE = standard error, *$p < 0.05$

Discussion

The results reveal specific properties and structures of the analyzed PAP network. First of all, the community department for education and sports held as by far the most central position within the network. This may be due to the fact that it is responsible for the community sports promotion and, e.g., allocates financial resources to sports clubs or coordinates cooperation between sports clubs and schools. The density and the average degree of the entire network were relatively low with a total of eleven isolated organizations, indicating a rather sparse network. Most of the isolated organizations were from the private sector. One possible explanation for this would be that, on the one hand, these organizations might not have a great need for cooperation because they are not dependent on the (financial) resources from the community, as do sports clubs for example. On the other hand, since establishing and maintaining cooperation is costly, profit-oriented organizations might not develop new relationships for social reasons but only if they promise an economic benefit. Among the isolated actors were also some kindergartens. To introduce children to PA at an early age, it is important to develop strategies on how to integrate these institutions into the network so that they can benefit from exchanging information and resources with other organizations.

One question that arises is whether a higher network density would lead to better network results since many ties can be redundant and time consuming and a lower number of ties may be more efficient. Varda and Retrum (2012) analyzed several public health collaboratives with the aim of determining specific factors that lead to a successful collaborative. Even though it seems to be quite challenging to define a specific set of aspects, they found out that organizational characteristics and interorganizational mechanisms do appear to affect outcomes. Since it can generally be assumed that public funding in these types of networks is rather limited, a higher density of interactions, growing levels of trust and the availability of a greater diversity of resources can bring added value to the network and increase the likelihood of positive outcomes (Retrum et al., 2013). In particular, with regard to the promotion of PA, previous research found out that the integration of isolated actors could increase the capacity of a network to promote active lifestyles (Loitz et al., 2017). Thus, it can be assumed that developing new cooperative ties within the current network is more of an advantage than a disadvantage.

The density of a network also has implications for its most effective governance. While networks with a high density can be controlled by the network members themselves, it makes sense for fragmented networks with a low density to be managed by an external organization (Provan & Kenis, 2007). In any case, an important aspect is to define and communicate specific network goals. With these in mind, it is constantly possible to check whether the current processes contribute to the defined goals and what must additionally be initiated in order to achieve them (Varda et al., 2012).

The results of the ERGMs revealed underlying mechanisms for the formation of cooperative relationships explained by both structural and attributive effects. Regarding the structural effects, preferential attachment could be observed in the PAP network indicating a substantial tendency of organizations to cooperate with organizations that are already involved in a higher number of ties. This effect can primarily be attributed to the community department for education and sports, underlining its powerful position and influence on network processes. Multiple triangulation was also present in the analyzed network, indicating network closure. Therefore, cooperation seems to take place, at least in part, in smaller clusters based on mutual trust and initiated by the organizations themselves as a bottom-up movement. Comparable patterns were also

observed in another community network that evolved around sports and physical activity (Wäsche, 2015).

As far as attributive effects are concerned, ERGMs revealed a heterophily effect indicating that being situated in different sectors appears to be a strong predictor for cooperation in the analyzed PAP network. The mechanism of cooperation occurring in multisectoral clusters was also found in a previous study (Meisel et al., 2014). The establishment of heterophil relations to other organizations to get access to more diverse information or resources than that available in one's own sector meets the demand of Bevc et al. (2015a) to work across boundaries and unite different sectors in public health collaboratives. Hypothesis 4, which presumed that PAP organizations that own a sports facility show a higher activity in developing cooperative ties could not be confirmed. One possible explanation would be that the allocation of public sports facilities is coordinated by an external organization, which is why actors within the network may not need to establish cooperative ties among themselves in order to be able to access sports facilities. Moreover, the majority of the network organizations already owned a sports facility. A reason for this finding is probably that the city where the study takes place supports sports clubs which possess their own sports facilities in favor of providing sports facilities for the clubs. Therefore, especially many sports clubs had no need to cooperate in this regard. In addition, actors who do not possess a sports facility may also cooperate with organizations outside the network boundaries that were not considered in this study.

Since the analyzed network is an informal network and not a formally established one, an appropriate governance form still needs to be developed to manage the network effectively. Referring back to Provan and Kenis' (2007) network governance criteria, the overall network density was relatively low with a high degree of centralization, a moderate number of actors and a probably rather low consensus on the goals to be achieved. Accordingly, a lead organization taking over the governance of the network seems to be suitable. Although the community department for education and sports currently occupies a very central position within the network, it is mainly responsible for allocating financial resources and sports facilities and does not act strategically in the sense of a leadership role. In this respect, it remains to be determined whether the community department for education and sports should assume this role in the future or whether another organization would be more suitable. The role of the lead

organization can also be assumed by several central actors, who could then form a leading group to manage the network (Wäsche & Gerke, 2019). The properties of the analyzed network further suggest that cooperation often takes place in small triangular clusters characterized by mutual trust. These clusters consist of only a small number of participants who are in close and reciprocal contact and pursue common goals. For these small networks within the large network, a shared governance form might be appropriate, in which the participants themselves take over the governance (Provan & Kenis, 2007; Wäsche & Gerke, 2019). Therefore, a hybrid of a lead organization- or leading group-governed network and a participant-governed network might be most effective to manage and develop the analyzed PAP network.

The current study has some limitations that should be considered when evaluating the results. Despite repeated reminders, some organizations were unwilling to take part in the survey, so that probably not all cooperative relationships could be assessed. Therefore, we reconstructed as many of the ties as possible by symmetrization. In addition, the organizations surveyed did not have a uniform, precise understanding of the boundaries of the city district whereupon the radius was extended by 500 m, so that organizations near the boundary of the district were also included. Another limitation could be that the organizations' contact persons who answered the questionnaire did not know in detail about all cooperative relationships. It should also be noted that a network analysis can only provide a snapshot of the cooperative activities existing at the time of the survey. Moreover, the survey referred to a specific city district which is part of a larger network of the whole city. Consequently, the results cannot be generalized without further elaboration. However, studies of specific networks like this are still the most common approach in network research as they are able to provide insights into the phenomena and mechanisms of a rather new research field. To add to a better understanding of interorganizational networks providing sports and physical activity, future studies should compare and summarize results of similar networks.

Conclusions

The current study reveals specific characteristics of the interorganizational PAP network and enables an understanding of how cooperation in this network works. Descriptive results such as the identification of isolated and central actors can provide starting points for which central actors should be used to disseminate information and how

isolated or peripheral actors can be integrated in order to increase network interaction, cohesion and trust. Furthermore, the ERGMs show valid and robust findings on conditions of network formation and significant mechanisms of interorganizational cooperation, such as preferential attachment, closure or sector heterophily. This can provide valuable knowledge for developing measures on how to intensify existing and establish new cooperative ties among organizations and how to manage networks effectively and efficiently with the aim of promoting PA in an urban setting. For the present network, a first step would be to bring the organizations together and identify and define common goals that everyone is working towards (Varda et al., 2012).

Based on the similarities of the study findings with other network studies (Jones et al., 2017; Jones et al., 2018; Meisel et al., 2014; Wäsche, 2015), future research should begin to establish a theoretical framework by which recommendations for network development can be derived. SNA and especially stochastic network analysis are relatively new approaches in PA and sports sciences (Wäsche et al., 2017). Future studies should consider the application of these methods, since they offer a powerful toolbox to analyze relational phenomena in the public health sector as well as in other bordering research areas as was demonstrated by this study.

References

Agranoff, R. (2003). *Leveraging networks: A guide for public managers working across organizations*. IBM Endowment for the Business of Government.

An, R., Khan, N., Loehmer, E., & McCaffrey, J. (2017). Assessing the network of agencies in local communities that promote healthy eating and lifestyles among populations with limited resources. *American Journal of Health Behavior*, *41*(2), 127–138. https://doi.org/10.5993/AJHB.41.2.3

An, R., Loehmer, E., Khan, N., Scott, M. K., Rindfleisch, K., & McCaffrey, J. (2017). Community partnerships in healthy eating and lifestyle promotion: A network analysis. *Preventive Medicine Reports*, *6*, 294–301. https://doi.org/10.1016/j.pmedr.2017.03.007

Barabasi, A. (1999). Emergence of scaling in random networks. *Science*, *286*(5439), 509–512. https://doi.org/10.1126/science.286.5439.509

Barnes, M., MacLean, J., & Cousens, L. (2010). Understanding the structure of community collaboration: The case of one Canadian health promotion network.

Health Promotion International, *25*(2), 238–247. https://doi.org/10.1093/heapro/daq002

Bauman, A. E., Reis, R. S., Sallis, J. F., Wells, J. C., Loos, R. J. F., & Martin, B. W. (2012). Correlates of physical activity: Why are some people physically active and others not? *The Lancet*, *380*(9838), 258–271. https://doi.org/10.1016/S0140-6736(12)60735-1

Bevc, C. A., Retrum, J. H., & Varda, D. M. (2015a). New perspectives on the "silo effect": Initial comparisons of network structures across public health collaboratives. *American Journal of Public Health*, *105*(Suppl. 2), 230-235. https://doi.org/10.2105/AJPH.2014.302256

Bevc, C. A., Retrum, J. H., & Varda, D. M. (2015b). Patterns in PARTNERing across public health collaboratives. *International Journal of Environmental Research and Public Health*, *12*(10), 12412–12425. https://doi.org/10.3390/ijerph121012412

Borgatti, S. P., Everett, M. G., & Freeman, L. C. (2002). *Ucinet for windows: Software for social network analysis* (Version 6.721) [Computer software]. Analytic Technologies. http://www.analytictech.com/archive/ucinet.htm

Borgatti, S. P., Everett, M. G., & Johnson, J. C. (2013). *Analyzing social networks*. SAGE.

Borgatti, S. P., Mehra, A., Brass, D. J., & Labianca, G. (2009). Network analysis in the social sciences. *Science*, *323*(5916), 892–895. https://doi.org/10.1126/science.1165821

Brandes, U., & Wagner, D. (2011). *Visone: Visual social networks* (Version 2.19) [Computer software]. University of Konstanz & Karlsruhe Institute of Technology. https://visone.ethz.ch/

Brownson, R. C., Parra, D. C., Dauti, M., Harris, J. K., Hallal, P. C., Hoehner, C., Malta, D. C., Reis, R. S., Ramos, L. R., Ribeiro, I. C., Soares, J., & Pratt, M. (2010). Assembling the puzzle for promoting physical activity in Brazil: A social network analysis. *Journal of Physical Activity and Health*, *7*(Suppl. 2), 242-252. https://doi.org/10.1123/jpah.7.s2.s242

Buchthal, O. V., Taniguchi, N., Iskandar, L., & Maddock, J. (2013). Assessing state-level active living promotion using network analysis. *Journal of Physical Activity and Health*, *10*(1), 19–32. https://doi.org/10.1123/jpah.10.1.19

Burt, R. S. (1992). *Structural holes: The social structure of competition*. Harvard University Press.

Butterfoss, F. D., Goodman, R. M., & Wandersman, A. (1996). Community coalitions for prevention and health promotion: Factors predicting satisfaction, participation, and planning. *Health Education Quarterly*, *23*(1), 65–79. https://doi.org/10.1177/109019819602300105

Contandriopoulos, D., Hanusaik, N., Maximova, K., Paradis, G., & O'Loughlin, J. L. (2016). Cartographie des relations de collaboration entre les organismes canadiens de prévention pour les maladies chroniques [Mapping Collaborative Relations among Canada's Chronic Disease Prevention Organizations]. *Healthcare Policy / Politiques De Sante*, *12*(1), 101–115.

de la Haye, K., Robins, G., Mohr, P., & Wilson, C. (2010). Obesity-related behaviors in adolescent friendship networks. *Social Networks*, *32*(3), 161–167. https://doi.org/10.1016/j.socnet.2009.09.001

Emirbayer, M. (1997). Manifesto for a relational sociology. *American Journal of Sociology*, *103*(2), 281–317. https://doi.org/10.1086/231209

Erlhofer, S. (2010). Missing Data in der Netzwerkanalyse. In C. Stegbauer (Ed.), *Netzwerkanalyse und Netzwerktheorie: Ein neues Paradigma in den Sozialwissenschaften* (pp. 251–260). VS Verlag für Sozialwissenschaften. https://doi.org/10.1007/978-3-531-92029-0_19

Freeman, L. C. (1978). Centrality in social networks conceptual clarification. *Social Networks*, *1*(3), 215–239. https://doi.org/10.1016/0378-8733(78)90021-7

Goodreau, S. M., Kitts, J. A., & Morris, M. (2009). Birds of a feather, or friend of a friend? Using exponential random graph models to investigate adolescent social networks. *Demography*, *46*(1), 103–125. https://doi.org/10.1353/dem.0.0045

Guthold, R., Stevens, G. A., Riley, L. M., & Bull, F. C. (2018). Worldwide trends in insufficient physical activity from 2001 to 2016: A pooled analysis of 358 population-based surveys with 1·9 million participants. *The Lancet Global Health*, *6*(10), e1077-e1086. https://doi.org/10.1016/S2214-109X(18)30357-7

Hall, J. A., & Valente, T. W. (2007). Adolescent smoking networks: The effects of influence and selection on future smoking. *Addictive Behaviors*, *32*(12), 3054–3059. https://doi.org/10.1016/j.addbeh.2007.04.008

Hambrick, M. E., Svensson, P. G., & Kang, S. (2019). Using social network analysis to investigate interorganizational relationships and capacity building within a sport for development coalition. *Sport Management Review*, *22*(5), 708–723. https://doi.org/10.1016/j.smr.2018.12.002

Hamer, M., O'Donovan, G., & Murphy, M. (2017). Physical inactivity and the economic and health burdens due to cardiovascular disease: Exercise as medicine. In J. Xiao (Ed.), *Exercise for cardiovascular disease prevention and treatment: From molecular to clinical, Part 1* (pp. 3–18). Springer Singapore. https://doi.org/10.1007/978-981-10-4307-9_1

Hennig, M., Brandes, U., Pfeffer, J [Jürgen], & Mergel, I. (2012). *Studying social networks: A guide to empirical research* (1st ed.). Campus Verlag. http://gbv.eblib.com/patron/FullRecord.aspx?p=1026766

Jones, G. J., Edwards, M., Bocarro, J. N., Bunds, K. S., & Smith, J. W. (2017). Collaborative advantages: The role of interorganizational partnerships for youth sport nonprofit organizations. *Journal of Sport Management*, *31*(2), 148–160. https://doi.org/10.1123/jsm.2016-0118

Jones, G. J., Edwards, M. B., Bocarro, J. N., Bunds, K. S., & Smith, J. W. (2018). A structural perspective of cross-sector partnerships involving youth sport nonprofit organizations. *European Sport Management Quarterly*, *18*(2), 133–155. https://doi.org/10.1080/16184742.2017.1322625

Kadushin, C. (2012). *Understanding social networks: Concepts, theories, and findings*. Oxford University Press. http://lib.myilibrary.com/detail.asp?ID=342698

Lasker, R. D., & Weiss, E. S. (2003). Broadening participation in community problem solving: A multidisciplinary model to support collaborative practice and research. *Journal of Urban Health*, *80*(1), 14-47. https://doi.org/10.1093/jurban/jtg014

Loitz, C. C., Stearns, J. A., Fraser, S. N., Storey, K., & Spence, J. C. (2017). Network analysis of inter-organizational relationships and policy use among active living organizations in Alberta, Canada. *BMC Public Health*, *17*(1), Article 649. https://doi.org/10.1186/s12889-017-4661-5

Luke, D. A., & Harris, J. K. (2007). Network analysis in public health: History, methods, and applications. *Annual Review of Public Health*, *28*, 69–93. https://doi.org/10.1146/annurev.publhealth.28.021406.144132

Lusher, D., Robins, G., & Koskinen, J. (Eds.). (2013). *Exponential random graph models for social networks: Theory, methods, and applications*. Cambridge University Press. https://doi.org/10.1017/CBO9780511894701

Mays, G. P., & Scutchfield, F. D. (2010). Improving public health system performance through multiorganizational partnerships. *Preventing Chronic Disease*, *7*(6), Article 116.

McCullough, J. M., Eisen-Cohen, E., & Salas, S. B. (2016). Partnership capacity for community health improvement plan implementation: Findings from a social network analysis. *BMC Public Health*, *16*(1), Article 566. https://doi.org/10.1186/s12889-016-3194-7

McLeroy, K. R., Bibeau, D., Steckler, A., & Glanz, K. (1988). An ecological perspective on health promotion programs. *Health Education Quarterly*, *15*(4), 351–377. https://doi.org/10.1177/109019818801500401

Meisel, J. D., Sarmiento, O. L., Montes, F., Martinez, E. O., Lemoine, P. D., Valdivia, J. A., Brownson, R. C., & Zarama, R. (2014). Network analysis of Bogotá's Ciclovía Recreativa, a self-organized multisectorial community program to promote physical activity in a middle-income country. *American Journal of Health Promotion*, *28*(5), e127-e136. https://doi.org/10.4278/ajhp.120912-QUAN-443

Moreno, J. L. (1934). *Who shall survive? A new approach to the problem of human interrelations*. Nervous and Mental Disease Publishing Co. https://doi.org/10.1037/10648-000

Mouttapa, M., Valente, T. W., Gallaher, P., Rohrbach, L. A., & Unger, J. B. (2004). Social network predictors of bullying and victimization. *Adolescence*, *39*(154), 315–335.

Parra, D. C., Dauti, M., Harris, J. K., Reyes, L., Malta, D. C., Brownson, R. C., Quintero, M. A., & Pratt, M. (2011). How does network structure affect partnerships for promoting physical activity? Evidence from Brazil and Colombia. *Social Science & Medicine*, *73*(9), 1365–1370. https://doi.org/10.1016/j.socscimed.2011.08.020

Pfeffer, J [Jeffrey], & Salancik, G. R. (1978). *The external control of organizations: A resource dependence perspective*. Harper & Row Publishers.

Powell, W. W. (1990). Neither market nor hierarchy: Network forms of organization. *Research in Organizational Behavior*, *12*, 295–336.

Provan, K. G., & Kenis, P. (2007). Modes of network governance: Structure, management, and effectiveness. *Journal of Public Administration Research and Theory*, *18*(2), 229–252. https://doi.org/10.1093/jopart/mum015

Provan, K. G., & Milward, H. B. (2001). Do networks really work? A framework for evaluating public-sector organizational networks. *Public Administration Review*, *61*(4), 414–423. http://www.jstor.org/stable/977503

Provan, K. G., Veazie, M. A., Staten, L. K., & Teufel-Shone, N. I. (2005). The use of network analysis to strengthen community partnerships. *Public Administration Review*, *65*(5), 603–613. https://doi.org/10.1111/j.1540-6210.2005.00487.x

Reiner, M., Niermann, C., Jekauc, D., & Woll, A. (2013). Long-term health benefits of physical activity - A systematic review of longitudinal studies. *BMC Public Health*, *13*(1), Article 813. https://doi.org/10.1186/1471-2458-13-813

Retrum, J. H., Chapman, C. L., & Varda, D. M. (2013). Implications of network structure on public health collaboratives. *Health Education & Behavior*, *40*(1, Suppl.), S13–S23. https://doi.org/10.1177/1090198113492759

Robins, G., Lewis, J. M., & Wang, P. (2012). Statistical network analysis for analyzing policy networks. *Policy Studies Journal*, *40*(3), 375–401. https://doi.org/10.1111/j.1541-0072.2012.00458.x

Robins, G., Pattison, P., Kalish, Y., & Lusher, D. (2007). An introduction to exponential random graph (p*) models for social networks. *Social Networks*, *29*(2), 173–191. https://doi.org/10.1016/j.socnet.2006.08.002

Robins, G., Snijders, T., Wang, P., Handcock, M., & Pattison, P. (2007). Recent developments in exponential random graph (p*) models for social networks. *Social Networks*, *29*(2), 192–215. https://doi.org/10.1016/j.socnet.2006.08.003

Rowe, K., Shilbury, D., Ferkins, L., & Hinckson, E. (2013). Sport development and physical activity promotion: An integrated model to enhance collaboration and understanding. *Sport Management Review*, *16*(3), 364–377. https://doi.org/10.1016/j.smr.2012.12.003

Sallis, J. F., Cervero, R. B., Ascher, W., Henderson, K. A., Kraft, M. K., & Kerr, J. (2006). An ecological approach to creating active living communities. *Annual Review of Public Health*, *27*, 297–322. https://doi.org/10.1146/annurev.publhealth.27.021405.102100

Schoen, M. W., Moreland-Russell, S., Prewitt, K., & Carothers, B. J. (2014). Social network analysis of public health programs to measure partnership. *Social*

Science & Medicine, *123*, 90–95. https://doi.org/10.1016/j.socscimed.2014.10.057

Thibault, L., Kikulis, L. M., & Frisby, W. (2010). Partnerships between local government sport and leisure departments and the commercial sector: Changes, complexities and consequences. In T. Slack (Ed.), *The commercialisation of sport* (1st ed.). Routledge.

Timm, I., Rapp, S., Jeuter, C., Bachert, P., Reichert, M., Woll, A., & Wäsche, H. (2021). Interorganizational networks in physical activity promotion: A systematic review. *International Journal of Environmental Research and Public Health*, *18*(14), Article 7306. https://doi.org/10.3390/ijerph18147306

Valente, T. W., Chou, C. P., & Pentz, M. A. (2007). Community coalitions as a system: Effects of network change on adoption of evidence-based substance abuse prevention. *American Journal of Public Health*, *97*(5), 880–886. https://doi.org/10.2105/AJPH.2005.063644

Valente, T. W., Fujimoto, K., Palmer, P., & Tanjasiri, S. P. (2010). A network assessment of community-based participatory research: Linking communities and universities to reduce cancer disparities. *American Journal of Public Health*, *100*(7), 1319–1325. https://doi.org/10.2105/AJPH.2009.171116

Varda, D. M., Chandra, A., Stern, S. A., & Lurie, N. (2008). Core dimensions of connectivity in public health collaboratives. *Journal of Public Health Management and Practice*, *14*(5), E1-7. https://doi.org/10.1097/01.PHH.0000333889.60517.46

Varda, D. M., & Retrum, J. H. (2012). An exploratory analysis of network characteristics and quality of interactions among public health collaboratives. *Journal of Public Health Research*, *1*(2), 170–176. https://doi.org/10.4081/jphr.2012.e27

Varda, D. M., Shoup, J. A., & Miller, S. (2012). A systematic review of collaboration and network research in the public affairs literature: Implications for public health practice and research. *American Journal of Public Health*, *102*(3), 564–571. https://doi.org/10.2105/AJPH.2011.300286

Waitz, C, Quint, A., Trenks, H., Parodi, O., Jäkel, A., Lezuo, D., & Wäsche, H. (2017). Das Reallabor als Motor für nachhaltige Quartiersentwicklung: Erfahrungen aus dem Karlsruher Experimentierraum. *Berichte. Geographie Und Landeskunde*, *91*(1), 67–80.

Wang, P., Robins, G., & Pattison, P. (2009). *PNet: Program for the simulation and estimation of exponential random graph models* (Version 1.0) [Computer software]. Melbourne School of Psychological Sciences, The University of Melbourne.

Wäsche, H. (2015). Interorganizational cooperation in sport tourism: A social network analysis. *Sport Management Review*, *18*(4), 542–554. https://doi.org/10.1016/j.smr.2015.01.003

Wäsche, H., Beecroft, R., Trenks, H., Seebacher, A., & Parodi, O. (2021). Transdisciplinary sport and physical activity development in urban real-world labs. *International Journal of Sports Marketing and Sponsorship*, *22*(4), 816–833. https://doi.org/10.1108/IJSMS-05-2020-0081

Wäsche, H., Dickson, G., Woll, A., & Brandes, U. (2017). Social network analysis in sport research: An emerging paradigm. *European Journal for Sport and Society*, *14*(2), 138–165. https://doi.org/10.1080/16138171.2017.1318198

Wäsche, H., & Gerke, A. (2019). Interorganisational network governance in sport. In M. Winand & C. Anagnostopoulos (Eds.), *Research Handbook on Sport Governance* (pp. 202–215). Edward Elgar Publishing. https://doi.org/10.4337/9781786434821.00021

Wolbring, L., Reimers, A. K., Niessner, C., Demetriou, Y., Schmidt, S. C. E., Woll, A., & Wäsche, H. (2021). How to disseminate national recommendations for physical activity: A qualitative analysis of critical change agents in Germany. *Health Research Policy and Systems*, *19*(1), Article 78. https://doi.org/10.1186/s12961-021-00729-7

World Health Organization. (2018). *More active people for a healthier world: Global action plan on physical activity 2018-2030*. World Health Organization. https://www.who.int/publications/i/item/9789241514187

Yessis, J., Riley, B., Stockton, L., Brodovsky, S., & Sychowski, S. von (2013). Interorganizational relationships in the Heart and Stroke Foundation's Spark Together for Healthy Kids™: Insights from using network analysis. *Health Education & Behavior*, *40*(1, Suppl.), S43–S50. https://doi.org/10.1177/1090198113490724

S1: Supporting information 1 - Survey items for data collection

1. German version (original language)

1.1 Possession of sports facility

Verfügt Ihre Einrichtung über Sportstätten in der Oststadt?

Unter Sportstätten werden Sportanlagen (primär für den Sport geschaffen) oder Sportgelegenheiten (für andere Zwecke geschaffen, aber explizit dem Sport zur Verfügung stehende Räume, Plätze etc.) verstanden. Bitte geben Sie den Namen, Adresse, Art der Sportstätte sowie die jeweilige Größe in Quadratmetern (qm) an und ob sie für jedermann öffentlich zugänglich ist oder nicht. Berücksichtigen Sie dabei bitte, ob die Sportstätte im eigenen Besitz, zur Pacht oder in Pflege ist und machen Sie die Angaben im jeweiligen Feld.

	Name	Adresse	Art der Sportstätte	Größe in qm	Öffentlich zugänglich? (ja/nein)
im eigenen Besitz:					
im eigenen Besitz:					
im eigenen Besitz:					
zur Pacht/Miete:					
zur Pacht/Miete:					
zur Pacht/Miete:					
zur Pflege:					
zur Pflege:					
Zur Pflege:					

1.2 Identifying cooperation network

Mit welchen Einrichtungen kooperieren Sie im Rahmen Ihres Sportangebots in der Oststadt?

Bitte geben Sie an, mit welchen Einrichtungen (Schulen, Vereine, Kindergärten, freie Sportanbieter, Sportverwaltung, Kirchen und Altenpflegeeinrichtungen) Sie im Rahmen Ihres Sportangebots in der Oststadt kooperieren. Beziehen Sie sich dabei auf die Einrichtungen in nachfolgender Liste. Um die Liste zu betrachten, klicken Sie bitte auf den folgenden Hyperlink:

Liste der sportanbietenden und -verwaltenden Einrichtungen in oder mit Bezug zur Oststadt

Die Liste öffnet sich dann in einem neuen Fenster Ihres Browsers, während die Umfrage im Hintergrund geöffnet bleibt. Sie können bis zu zehn Einrichtungen nennen. Falls Sie mit mehr als zehn Einrichtungen kooperieren, nennen Sie nur die zehn wichtigsten. Beurteilen Sie für jede von Ihnen angeführte Einrichtung die Art der Kooperation (Mehrfachantworten sind möglich):

- es findet ein Austausch von Informationen statt
- es findet ein Austausch von Personal statt
- es findet eine Zusammenarbeit bei Sport- und Bewegungsangeboten statt
- es findet eine gemeinsame Nutzung von Sportstätten statt

	Austausch von Informationen	Austausch von Personal	Zusammenarbeit bei Angeboten	Nutzung von Sportstätten
Name der Einrichtung:	□	□	□	□
Name der Einrichtung:	□	□	□	□
Name der Einrichtung:	□	□	□	□
Name der Einrichtung:	□	□	□	□
Name der Einrichtung:	□	□	□	□
Name der Einrichtung:	□	□	□	□
Name der Einrichtung:	□	□	□	□
Name der Einrichtung:	□	□	□	□
Name der Einrichtung:	□	□	□	□
Name der Einrichtung:	□	□	□	□

2. English version

2.1 Possession of sports facility

Does your organization have sports facilities in the Oststadt?

Sports facilities are understood to be sports facilities (primarily created for sports) or sports opportunities (rooms, places, etc. created for other purposes, but explicitly available for sports). Please indicate the name, address, type of sports facility as well as the respective size in square meters (sqm) and whether it is open to the public or not. Please take into account whether the sports facility is owned, leased or maintained and provide the information in the respective field.

	name	address	type of sports facility	size in sqm	open to the public? (yes/no)
in own possession:					
in own possession:					
in own possession:					
leased:					
leased:					
leased:					
for maintenance:					
for maintenance:					
for maintenance:					

2.2 Identifying cooperation network

With which organizations do you cooperate as part of your sports offerings in the Oststadt?

Please indicate with which institutions (schools, sports clubs, kindergartens, commercial sports providers, sports administration, churches and old people’s homes) you cooperate as part of your sports offering in the Oststadt. Refer to the organizations in the list below. To view the list, please click on the following hyperlink:

List of sports-providing and -administrating organizations in or related to the Oststadt.

The list will open in a new window in your browser while the survey remains open in the background. You can name up to ten organizations. If you cooperate with more than ten organizations, name only the most important ten. For each organization you name, rate the type of cooperation (multiple answers are possible):

- there is an exchange of information

- there is an exchange of personnel

- there is a cooperation in the provision of sports and physical activity programs

- there is a joint use of sports facilities

	exchange of information	exchange of personnel	cooperation on programs	use of sports facilities
name of the organization:				
	□	□	□	□
name of the organization:				
	□	□	□	□
name of the organization:				
	□	□	□	□
name of the organization:				
	□	□	□	□
name of the organization:				
	□	□	□	□
name of the organization:				
	□	□	□	□
name of the organization:				
	□	□	□	□
name of the organization:				
	□	□	□	□
name of the organization:				
	□	□	□	□
name of the organization:				
	□	□	□	□

Chapter 4: Community networks of sport and physical activity promotion

Paper III: Community networks of sport and physical activity promotion: An analysis of structural properties and conditions of cooperation

Slightly modified version of the published paper

Wolbring, L., Schmidt, S. C. E., Niessner, C., Woll, A., & Wäsche, H. (2022). Community networks of sport and physical activity promotion: An analysis of structural properties and conditions of cooperation. *BMC Public Health*, *22*, Article 1966. https://doi.org/10.1186/s12889-022-14383-3

Abstract

Background: The importance of intersectoral cooperation networks among community organizations located in people's immediate environments in addressing population health problems such as physical inactivity has come into focus in recent years. To date, there is limited evidence on how and why such networks emerge. Therefore, the aims of this study were (a) to analyze the *structural properties* and (b) to identify the *conditions of cooperation* in interorganizational community networks of sport and physical activity promotion.

Methods: Survey data on cooperative relationships and organizational attributes of sports and physical activity providers as well as sports administrating organizations in two community networks located in urban districts in southern Germany were collected (Network I: n = 133 organizations; Network II: n = 50 organizations). Two quantitative descriptive procedures – network analysis and stochastic analyses of network modeling (exponential random graphs) – were applied.

Results: Similar structures and conditions of cooperation were found in the networks (e.g. low density, centralization). The community sports administrations had the most central positions in both networks. Exponential random graph modeling showed that cooperation took place more frequently in triangular structures (closure effect) and revolved around a few central actors (preferential attachment effect). Organizations from different sectors cooperated more often than organizations from the same sector (heterophily effect).

Conclusions: The study provided valid and robust findings on significant mechanisms and conditions of interorganizational cooperation in community networks focused on sport and physical activity promotion. Based on the results, implications for the development and most efficient governance of these networks can be derived.

Keywords

Health promotion, Interorganizational cooperation, Social network analysis, Sport development

Background

The importance of sport and physical activity (PA) in the prevention of non-communicable diseases has been widely demonstrated (Reiner et al., 2013). However, recent studies have shown that PA levels worldwide are low (Aubert et al., 2018; Guthold et al., 2018). In Germany, for example, PA recommendations were only met by a quarter of children and adolescents (Schmidt et al., 2020) while about 40 % of German adults show insufficient PA behavior (Guthold et al., 2018). Due to increased mortality rates and health care costs (Ding et al., 2016; Hamer et al., 2017), physical inactivity represents a key social and economic challenge.

Individual behavioral interventions have proven insufficient to promote sport and PA at the population level (Frieden et al., 2010; Sallis et al., 2009). Instead, interventions aimed at changing systems while taking into account the social and physical environment in which people live have received increasing attention (Bornstein et al., 2013; Heath et al., 2012). The World Health Organization (2018) not only calls for the provision of individual PA programs and opportunities but also for the development of active systems. In this context, the focus lies on intersectoral cooperation between relevant stakeholders and improved governance to enable social and environmental development and ensure sustainable sport and PA promotion.

To address the rather low PA levels of the German population, the German Federal Ministry of Health published the National Recommendations for PA and PA Promotion (NRPP) (Rütten & Pfeifer, 2016). These emphasize the need for PA promotion especially in community settings. While there are projects to implement the promotion of PA on a community level (Kohler et al., 2021; Rütten et al., 2018), a systematic and nationwide implementation of the NRPP on a policy level is deficient. Therefore,

stakeholders call for sport and PA promotion to be given a higher priority on the political agenda, and for better networking of relevant actors including the community level (Wolbring et al., 2021).

The community is seen as a central setting in which sport and PA promotion should be implemented since this is the place where people live, learn, work, commute, and exercise (Sallis et al., 2006). Bauman et al. (2012) found that the existence of PA opportunities and recreational facilities in a person's immediate environment is of great significance when it comes to sport and PA participation. Thus, organizations providing and coordinating sports and PA at the community level and their cooperation efforts play an important role (Andrade et al., 2018; Meisel et al., 2014). In particular, the relevance of educational institutions, community departments, sports clubs, and recreational facilities is emphasized (Barnes et al., 2010). This is because they can provide better access to sports and PA and break down barriers to active transportation through coordinated cooperation and exchange (Sallis et al., 2006). These not only offer formal sports and PA programs but also provide spaces for informal sports, such as football fields, green spaces, or schoolyards.

The rationale for intersectoral cooperation is that public health challenges, such as physical inactivity, are very complex and multifaceted and therefore cannot be solved by single actors and organizations (Butterfoss et al., 1996; Provan, Veazie, et al., 2005). In addition, public funding in this area is scarce, which means that cooperation is essential in terms of uniting and sharing resources, information, and expertise (Bevc et al., 2015; Lasker & Weiss, 2003; Mays & Scutchfield, 2010; Varda et al., 2008). Ideas and solutions can be developed jointly and organizational capacity can be built together to address public health problems efficiently and effectively (Provan et al., 2003; Provan, Veazie, et al., 2005; Valente et al., 2015). Researchers have repeatedly emphasized that the health sector is not capable of solving these challenges on its own (Roussos & Fawcett, 2000). Therefore, it is necessary for organizations from various sectors to work together to draw on diverse resources and capabilities and to unite different perspectives on a problem that enables them to reach shared goals (Bevc et al., 2015; Bornstein et al., 2013; Provan & Kenis, 2007). However, intersectoral cooperation is also accompanied by challenges such as increased bureaucracy, differing agendas pursued by individual organizations, and increased time requirements (Timm

et al., 2021). To address these challenges and to increase network effectiveness, systematic network coordination and management is essential (Provan & Kenis, 2007).

The present study is based on three interrelated theoretical approaches: 1) systems thinking and the socio-ecological model; 2) network research; and 3) resource dependence theory. First, the concept of systems thinking (Leischow & Milstein, 2006; Trochim et al., 2006) seeks to go beyond linear and simplistic views of complex phenomena and emphasizes the complexity of social life (Rutter et al., 2017). It focuses on the diverse interactions of different components and facets of public health problems (Williams & Hummelbrunner, 2011). According to systems thinking, it is important to understand the different structures that shape people's lives as well as the interrelations between those structures. This is a necessary prerequisite to be able to transform systems that affect the public's health. In line with this, the socio-ecological model assumes that, beyond individual action, human behavior is shaped by existing structures at various levels and environments. To change people's PA behavior, the relevant environments, such as the organizational level, must be addressed (Kok et al., 2008; McLeroy et al., 1988; Sallis et al., 2006). Second, network research is based on the concept of systems thinking and adopts a relational perspective. That means phenomena of interest are explained by reference to their underlying structures. Accordingly, organizations are embedded in social structures and do not act in isolation but in mutual dependence. Thus, it is not the individual organizations that are the unit of analysis but their relationships to each other (Borgatti et al., 2018; Wäsche et al., 2017; Wasserman & Faust, 1994). Social network analysis (SNA) enables the identification of strengths and opportunities for improvement by analyzing the structure of relationships and interactions between organizations from diverse sectors pursuing different goals (Luke & Harris, 2007; Luke & Stamatakis, 2012). Third, according to resource dependence theory (Pfeffer & Salancik, 2009), organizations build cooperation to gain access to resources they do not possess themselves and thereby try to minimize risks and uncertainties (Drees & Heugens, 2013; Starkey et al., 2000; Stuart, 2000). Often, relationships are established with particularly popular organizations, which play a central role in the network and thus have a strong influence on network processes (Berardo & Scholz, 2010). In Barabási's terms, this phenomenon is known as scale-free networks (Barabasi, 1999).

SNA has been increasingly used in many areas of public health research to visualize and examine interorganizational cooperation (Fleuren et al., 2021; Luke & Harris, 2007; Provan, Veazie, et al., 2005) addressing, for example, tobacco control (Luke et al., 2010), child abuse prevention (Mulroy, 1997), HIV services (Kwait et al., 2001), health policy (Provan, Harvey, & Zapien, 2005), mental health services (Tausig, 1987), and the physical and social health of senior citizens (Kaluzny et al., 1998).

Studies on cooperation networks of organizations engaged in sport and PA promotion show rather heterogeneous results (Timm et al., 2021), both in terms of network characteristics and in terms of the predictors of cooperation. While some networks have a moderate to high density with a variety of realized relationships (McCullough et al., 2016; Parra et al., 2011; Yessis et al., 2013), other networks are rather fragmented with low levels of cooperation (An, Loehmer, et al., 2017; Andrade et al., 2018; Meisel et al., 2014; Wäsche, Wolbring, & Woll, 2021). In some networks, cooperation is characterized by centralization of a few actors that hold by far the highest number of cooperative ties or act as gatekeepers (Loitz et al., 2017; McCullough et al., 2016; Parra et al., 2011; Wäsche, Wolbring, & Woll, 2021), whereas in other networks the relationships between the organizations are evenly distributed and represent a decentralized network (An, Loehmer, et al., 2017; Andrade et al., 2018; Buchthal et al., 2013). There are also contrasting results regarding the conditions of cooperation. In some studies using SNA, organizations in the same sector cooperate more often with each other, indicating homophily as a mechanism of cooperative tie formation (An, Loehmer, et al., 2017; Brownson et al., 2010). However, other network studies have found that organizations from different sectors are more likely to establish a relationship, indicating heterophily as a mechanism of cooperative tie formation (Meisel et al., 2014; Parra et al., 2011; Wäsche, Wolbring, & Woll, 2021). An effect frequently observed is that cooperation in these networks takes place in triangles (Brownson et al., 2010; Meisel et al., 2014), i.e. in group-like structures characterized by mutual support and trust (Brandenberger et al., 2019; Burt & Knez, 1995; Powell, 1990).

The different findings can be attributed to various reasons: (1) Some of the networks studied not only included organizations based in the community but also organizations operating on higher administrative levels, such as the national, state, or county level (Brownson et al., 2010; Buchthal et al., 2013; Loitz et al., 2017; McCullough et al., 2016; Parra et al., 2011; Yessis et al., 2013). (2) Some of the networks are formally

organized with a clear structure and leadership (Barnes et al., 2010; Brownson et al., 2010; McCullough et al., 2016; Parra et al., 2011; Yessis et al., 2013), while others emerged unplanned without systematic governance (An, Loehmer, et al., 2017; Buchthal et al., 2013; Meisel et al., 2014). (3) Not all networks focus exclusively on sport and PA promotion but more generally on healthy lifestyles (An, Loehmer, et al., 2017; Yessis et al., 2013) or more specifically on active transportation (Zwald et al., 2019), resulting in different actor constellations. (4) The majority of studies used descriptive methods of network analysis (An, Khan, et al., 2017; An, Loehmer, et al., 2017; Barnes et al., 2010; Buchthal et al., 2013; Loitz et al., 2017; McCullough et al., 2016; Yessis et al., 2013), while only a small proportion used stochastic methods to uncover the mechanisms and conditions of network emergence (Andrade et al., 2018; Brownson et al., 2010; Meisel et al., 2014; Parra et al., 2011; Zwald et al., 2019). As a result, very few general conclusions concerning the processes and partnerships necessary to build and develop interorganizational community networks promoting sport and PA can be drawn to date. However, to ensure sustainable sport and PA promotion by strengthening partnerships, creating synergetic effects, and building capacity, it is essential to understand how these networks function.

Therefore, the aims of this study are (a) to analyze the *structural properties* and (b) to identify the *conditions of cooperation* in interorganizational community networks of sport and PA promotion. This study will add to the body of knowledge by moving beyond the description of network structures and focusing on organizational and structural predictors of interorganizational cooperation for sport and PA promotion on the community level. For this purpose, interorganizational networks of sport and PA promotion will be analyzed to identify how these networks are structured, how cooperation comes into being, and whether similar characteristics and mechanisms can be found. The findings can help to provide a better understanding of how community networks work and might help to uncover starting points for network development and effective network governance.

Methods

Sampling and procedure

The study took place in Germany, where sports and PA are principally organized in non-profit sports clubs as well as in the commercial fitness centers and gyms of the

private sector. The public sector includes mainly kindergartens, schools, and universities. Moreover, the public sector comprises community departments and administrations that play important roles due to funding as well as financial and material support for many sports and PA providers of the public and non-profit sector.

For our analysis, we used existing data on two networks in two different communities in southern Germany, which had been collected in earlier studies (Wäsche, Beecroft, et al., 2021; Wäsche et al., 2019; Woll et al., 2012). Hence, we performed a secondary analysis. Both networks were not formally established but emerged unplanned without a formal or strategic goal, also defined as serendipitous networks among organizations (Wäsche & Gerke, 2019). The organizations were connected by contributing to the total of opportunities for sports, PA, and recreational activities and were identified through the subsequent procedure. The data were collected by us following a comprehensive and systematic search to identify relevant community sports and PA providers as well as sports administrating and coordinating organizations. Based on a broad understanding of sports, not only traditional and commercial sports facilities and providers, such as sports clubs and gyms, but also institutions offering sports and PA programs of any form, such as schools, kindergartens, universities, social institutions, churches, and care facilities, were included. In addition, organizations that assumed superordinate, administrative, and advisory functions concerning sport and PA were taken into account. Data were collected in both networks through a standardized online questionnaire that was emailed to the identified organizations. To increase the response rate, follow-up was conducted by email or telephone if no response was received.

Network I was surveyed at the level of an entire city. The city had around 80,000 inhabitants. Initial data was collected in January and February 2012. Network II was surveyed at the level of a city district. The district had about 20,000 inhabitants, with the whole city having around 300,000. Data collection took place from May to August 2017.

Measures

Organizational characteristics

Organizations were divided into three sectors to test for homophily or heterophily as mechanisms of cooperative tie formation: the public sector (e.g. community administrations, schools, kindergartens, universities), the private sector (e.g. gyms, yoga studios, physical therapy practices), and the non-profit sector (e.g. sports clubs, social and church organizations). Additionally, all organizations were divided into for-profit (private sector) and non-profit (public and non-profit sector) organizations to test for activity effects based on for-profit orientation. Organizations in Network II were additionally asked whether they owned a sports facility located in the corresponding city district, as such a resource might trigger cooperation in the sense of resource dependence theory (Pfeffer & Salancik, 2009).

Network characteristics

The survey of cooperative relationships was based on previous studies (Brownson et al., 2010; Wäsche, 2015). Participants were given a list of all identified community sports and PA providers as well as sports administrating and coordinating organizations of the respective setting and were asked to indicate with whom they cooperate and what this cooperation looks like. Up to ten organizations with which a cooperative tie existed could be indicated. If organizations cooperated with more than ten other organizations, they were asked to only name the most important ten. In Network I, the cooperation had to be classified in each case according to one of the following four categories: exchange of information, informal cooperation (loose cooperation to achieve common goals), formal cooperation (close cooperation in a team to achieve common goals), and partnership (close cooperation over a longer period in different projects). In Network II, participants were asked to differentiate between the following cooperation types: exchange of information, exchange of personnel, cooperation on offers, and use of sports facilities. Detailed information on the questionnaires used for data collection can be found in Additional file 1.

As in previous studies (Brownson et al., 2010; Harris et al., 2008; Luke et al., 2010; Zwald et al., 2019), both networks were dichotomized so that organizations were considered to be linked if they indicated any type of cooperation. In this way, there is either a cooperative link or not and data can be compared more easily.

Data analysis

Descriptive analysis

To examine structural network properties, Ucinet Version 6.721 (Borgatti et al., 2002) and Visone Version 2.19 (Brandes & Wagner, 2011) were used. The networks were visualized and the following parameters were calculated.

On the network level, density (ratio of all realized relationships to the maximum number of possible relationships in the network), average degree (average number of relationships of the organizations), average distance (average shortest path between a set of two organizations), and degree centralization (extent to which all relationships of the network are organized around a few central organizations) were calculated. On the organizational (node) level, degree centrality (CD) (number of relationships with other organizations) and betweenness centrality (CB) scores (extent to which an organization acts as a bridge between two organizations that are not directly connected) were calculated for each organization. More information on the network parameters used can be found in Borgatti et al. (2018).

Exponential random graph models

To identify conditions and mechanisms of cooperation, we estimated exponential random graph models (ERGMs). ERGMs allow predictions about the probability of cooperative tie emergence between any two network organizations based on the properties of the network and organizational characteristics. They can provide evidence about rules for how and why certain relationships and their combinations occur while assuming that observations, such as network ties, are not independent (Harris, 2014). Networks are assumed to consist of smaller micro-configurations that describe the structure of the network. ERGMs allow conclusions to be drawn about whether certain micro-configurations in a network are observed more or less frequently than would be expected by chance. A distinction is made between structural network effects, which arise from within the network due to dynamics of self-organization, and attributive network effects, which are due to the characteristics of the organizations (Lusher et al., 2013; Robins, Pattison, et al., 2007; Robins, Snijders, et al., 2007).

We used Markov chain Monte Carlo methods to estimate the parameters of the ERGMs. Model building took place in three stages using R Version 4.0.5 (R Core

Team, 2021). Model 1 was a null model with no predictors, in model 2 we added the node attributes, and in model 3 the structural predictors were added.

Model 1. A simple random graph model, which contains only a single term, the edges term (number of relationships), and predicts the probability of a relationship in the network (Goodreau, 2007).

Model 2. Organizational characteristics were added to the model as node attributes to test their influence on cooperative tie formation. For-profit orientation and owning a sports facility (only in Network II) were added as dichotomous variables. Sector (public, private, non-profit) was included as a factor capturing a differential homophily effect, i.e. to test whether organizations tend to cooperate with organizations from the same sector or not.

Model 3. In this model, structural predictors were added to identify structural network effects. For this purpose, the three terms geometrically weighted edgewise shared partner distribution (GWESP), geometrically weighted degree distribution (GWDegree), and geometrically weighted dyad-wise shared partner distribution (GWDSP) were included (Hunter, 2007; Hunter, Goodreau, & Handcock, 2008; Hunter & Handcock, 2006; Hunter, Handcock, et al., 2008). These account for complex structures and dependency patterns in networks. The GWESP term was added to account for patterns of transitivity within the networks. It captures the tendency of two organizations that share a cooperative tie to form complete triangles with other organizations in the network. The GWDegree term captures the likelihood of organizations with higher degrees (relationships) forming cooperative ties with one another. The GWDSP term was included to measure the structural equivalence of the networks. It captures the tendency of dyads (a set of two unconnected organizations) to have shared neighbors.

To examine model fit, we compared Akaike information criterion (AIC) scores throughout model building. Smaller AIC scores indicate better fit. To check whether the final models (model 3 including attribute and structural predictors) represent the observed networks well, more in-depth goodness-of-fit tests were performed. For this purpose, the distribution of degree (proportion of nodes with respective number of ties), edgewise-shared partners (proportion of edges that show multiple triangulation), triad census (proportion of closed triangles), and minimum geodesic distance (proportion of

dyads with the respective shortest path between them) in the observed networks were compared to the distribution of the same characteristics in networks simulated based on the final ERGMs (Goodreau et al., 2008; Harris, 2014).

Results

Identified networks

Regarding Network I, a total of 213 relevant actors were identified, of which 159 responded to the survey (74.6 % response). Cooperative activity was identified in 104 organizations. Since binary data only provide information about whether a relationship exists or not and cooperation is inherently reciprocal, any cooperative tie from one organization to another can always be regarded as undirected and symmetrical (Borgatti et al., 2018). Thus, respective ties were reconstructed by symmetrization and included in the network for those organizations that had not participated in the survey themselves (n = 29). Therefore, the final cooperation Network I consisted of 133 organizations.

Out of 72 identified actors for Network II, 39 (54.2 % response) participated in the survey. 28 organizations indicated cooperative relationships with other organizations and 22 additional organizations could be reconstructed through symmetrization. Thus, the final cooperation Network II consisted of 50 organizations.

In both networks, mainly kindergartens and private sports providers were among the organizations showing no cooperative activity. In Network I, also church institutions as well as nursing homes indicated few or no cooperative ties to other organizations.

Structural properties

Organizational characteristics are displayed in Table 1. The proportion of public, private, and non-profit organizations was similar in both networks. Non-profit organizations made up the majority, followed by public organizations, with private organizations being the least represented. In Network I, the percentage of non-profit organizations was slightly higher than in Network II. On the other hand, organizations from the public and private sectors were less represented in Network I compared to Network II.

Table 1: Organizational characteristics of Network I and Network II

	Network I (*n* = 133)	**Network II** (*n* = 50)
Sector		
Public	32 (24.06 %)	18 (36 %)
Private	9 (6.77 %)	5 (10 %)
Non-profit	92 (69.17 %)	27 (54 %)
For-profit orientation		
Yes	9 (6.77 %)	5 (10 %)
No	124 (93.23 %)	45 (90 %)
Possession of a sports facility		
Yes	-	34 (68 %)
No	-	16 (32 %)

Data are represented in *n* (%)

Between the 133 organizations of Network I (Figure 1), 480 cooperative ties were realized. The average degree was 3.61 with a standard deviation (SD) of 3.57, indicating that one organization cooperated on average with three to four other organizations. In Network II (Figure 2), 148 cooperative relationships existed between the 50 network members and the average degree was 2.96 (SD = 3.75). The density of Network I was 0.03, which means that 3 % of all possible ties are realized. Network II also had a relatively low density with 0.06. The minimum number of relationships held by an organization in both networks was one. The maximum number of relationships was 19 in Network I and 23 in Network II. Network II was more centralized, with a degree centralization of 0.43 compared to Network I with a value of 0.12. Organizations were connected to all other actors in the network (average distance) through an average of 3.87 (SD = 1.38) ties in Network I and 2.70 (SD = 0.94) in Network II.

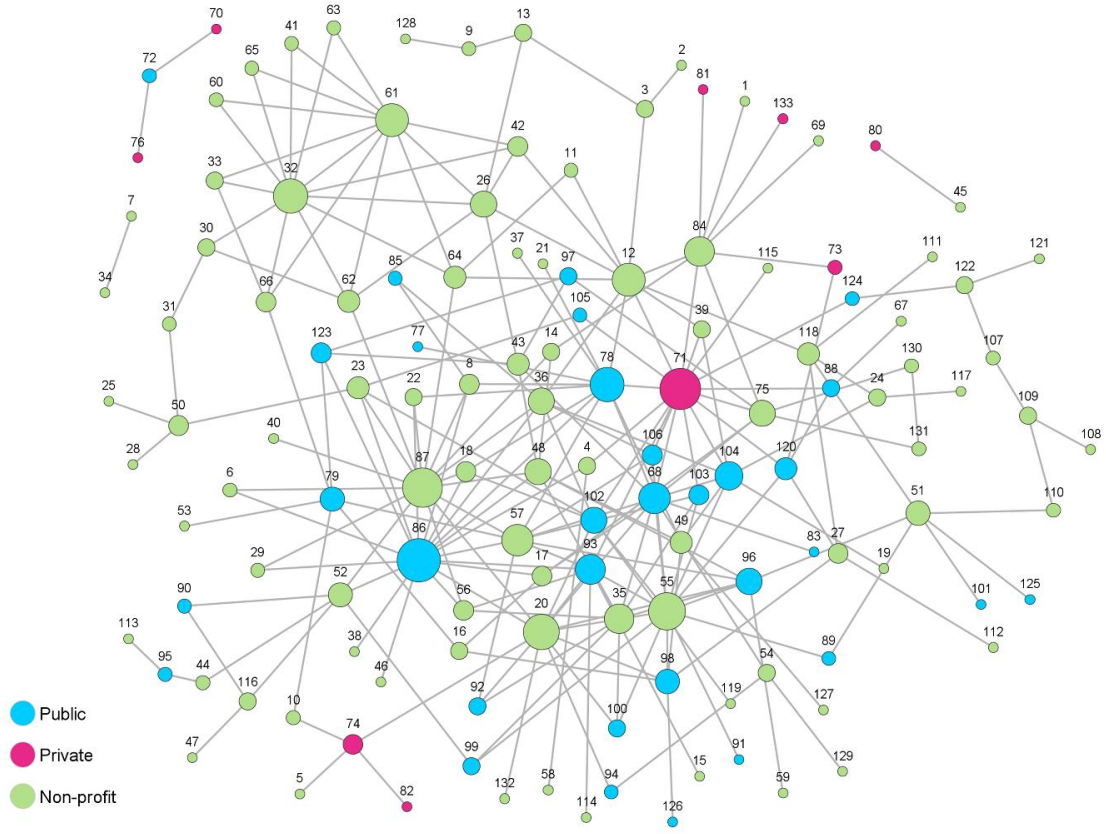


Figure 1: Network I (*n* = 133), ties between nodes indicate cooperation, node color represents sector affiliation, node size represents CD score (number of cooperative ties to other organizations)

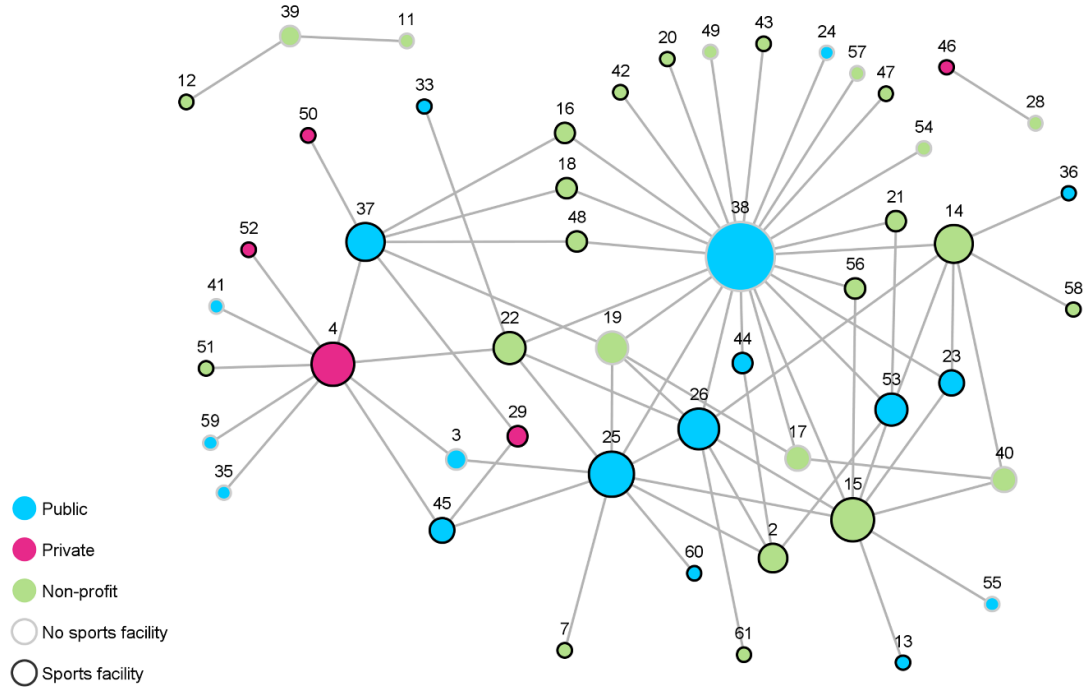


Figure 2: Network II (*n* = 50), ties between nodes indicate cooperation, node color represents sector affiliation, node boarder color represents possession of sports facility, node size represents CD score (number of cooperative ties to other organizations)

The CD and CB scores of the ten highest scoring organizations are displayed in Table 2. Based on the number of cooperative ties, the community sports administrations (Network I: node 86; Network II: node 38) occupy the most central position in both networks. Other central actors in Network I are a company that manages the community swimming pools (node 71), an association of all community sports clubs (node 87), and two sports clubs (node 55 and 20). In Network II, other central actors are a school (node 25), a private-sector health center (node 4), a sports club (node 15), and another school (node 26). It is noticeable that, in Network II, the community sports administration holds by far the most cooperative relationships (node 38, CD = 23) while the school in position 2 (node 25, CD = 10) has less than half as many connections. In Network I, on the other hand, the degree distribution seems to decrease linearly.

Table 2: Normalized CD and CB scores of the ten highest scoring organizations (Network I and II)

Network I					
Node ID	Type of organization	Sector	No. of ties	CD	CB
86	Community sports administration	Public	19	0.14	0.14
71	Administration of community swimming pools	Private	17	0.13	0.18
87	Association of community sports clubs	Non-profit	16	0.12	0.14
55	Local sports club	Non-profit	14	0.11	0.08
20	Local sports club	Non-profit	13	0.10	0.12
78	University sports provider	Public	12	0.09	0.07
32	Local sports club	Non-profit	12	0.09	0.05
12	Local life-saving organization	Non-profit	11	0.08	0.15
61	Local sports club	Non-profit	11	0.08	0.04
68	Health insurance company	Public	10	0.08	0.08
Network II					
Node ID	Type of organization	Sector	No. of ties	CD	CB
38	Community sports administration	Public	23	0.47	0.46

25	Public school	Public	10	0.20	0.16
4	Private health center	Private	9	0.18	0.19
15	Local sports club	Non-profit	9	0.18	0.10
26	Public school	Public	8	0.16	0.08
14	Educational outdoor park	Non-profit	7	0.14	0.08
37	University institute for sports	Public	7	0.14	0.09
19	Local sports club	Non-profit	5	0.10	0.04
22	Local sports club	Non-profit	5	0.10	0.16
53	Public school	Public	5	0.10	0.01

In Network I, the company that manages the community swimming pools (node 71) occupies the most central role regarding CB, indicating a powerful role in terms of information control within the network. It is followed by a local life-saving organization (node 12), the community sports administration (node 86), the association of all community sports clubs (node 87), and a sports club (node 20), which also held a high score concerning CD. In Network II, the community sports administration (node 38) not only holds the highest CD but also the highest CB score, which emphasizes its important role concerning the flow of information within the network. It is followed by the private health center (node 4), a sports club (node 22), the school (node 25), and another sports club (node 15), which also held a high score concerning CD.

ERGMs

The results of the ERGMs for Network I and Network II are displayed in Table 3. Below, we only refer to the final model 3 including the attribute and structural predictors.

Table 3: Exponential random graph models for Network I and Network II

	Network I								
	Model 1: Null model			Model 2: Attribute predictors			Model 3: Attribute and structural predictors		
Parameters	b (SE)	OR	CI	b (SE)	OR	CI	b (SE)	OR	CI
Edges	-3.57 (0.07)***	0.03	0.02-0.03	-3.31 (0.10)***	0.04	0.03-0.04	-3.24 (0.16)***	0.04	0.03-0.05
Attribute predictors									
Homophily									
Public sector				-0.58 (0.33)	0.56	0.29-1.08	-0.73 (0.35)*	0.48	0.24-0.95
Private sector				0.53 (1.09)	1.70	0.20-14.44	0.51 (1.17)	1.66	0.17-16.59
Non-profit sector				-0.42 (0.14)**	0.65	0.49-0.87	-0.36 (0.13)**	0.70	0.54-0.89
Activity									
For-profit orientation				-0.39 (0.22)	0.68	0.44-1.04	-0.31 (0.17)	0.74	0.53-1.02
Structural predictors									
GWESP							0.48 (0.08)***	1.62	1.38-1.89
GWDegree							-0.94 (0.21)***	0.39	0.26-0.59
Model fit									
AIC	2203			2201			2120		

	Network II								
	Model 1: Null model			Model 2: Attribute predictors			Model 3: Attribute and structural predictors		
Parameters	b (SE)	OR	CI	b (SE)	OR	CI	b (SE)	OR	CI
Edges	-2.74 (0.12)***	0.06	0.05-0.08	-2.35 (0.29)***	0.10	0.05-0.17	-2.30 (0.38)***	0.10	0.05-0.21
Attribute predictors									
Homophily									
Public sector				-0.32 (0.36)	0.72	0.35-1.47	-0.64 (0.42)	0.53	0.23-1.20
Private sector				1.22 (1.22)	3.40	0.31-37.14	1.30 (1.31)	3.65	0.28-47.58
Non-profit sector				-1.43 (0.39)***	0.24	0.11-0.52	-1.38 (0.44)**	0.25	0.11-0.60
Activity									
For-profit orientation				-0.55 (0.34)	0.58	0.29-1.13	-0.55 (0.30)	0.58	0.32-1.04
Sports facility				0.02 (0.19)	1.02	0.70-1.47	0.01 (0.15)	1.01	0.76-1.35
Structural predictors									
GWESP							0.36 (0.18)*	1.44	1.02-2.03
GWDegree							-0.84 (0.42)*	0.43	0.19-0.98
Model fit									
AIC	560.8			553			543		

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$. Abbreviations: b = estimate; SE = standard error; OR = odds ratio; CI = 95% confidence interval

Both models show some similarities regarding significant mechanisms of cooperative tie emergence. Concerning the attribute predictors, the estimate for the non-profit sector is significant and negative in both networks. This indicates that organizations from the non-profit sector cooperate with each other less frequently than would be expected by chance, which is also referred to as heterophily. For-profit orientation was not associated with higher cooperative activity in either network. Similarly, owning a sports facility (data only available Network II) did not influence cooperative activity.

With regard to structural network effects, we found a positive tendency for transitivity (GWESP) in both networks, meaning that collaborative ties are more likely to occur in triangular clusters. The GWDegree estimate is significant and negative in both models, which can be interpreted as a preferential attachment effect (Levy & Lubell, 2018), indicating that cooperation revolves around a few central organizations in both networks. The GWDSP parameter, indicating a tendency of dyads to have shared neighbors, was excluded in both models due to poor convergence.

The two networks differ concerning the cooperation of organizations from the public sector. While there is a heterophily effect for public sector organizations in Network I, meaning that public sector organizations are less likely than chance to cooperate, this effect is not significant in Network II.

Model fit

When comparing the AIC scores, the final model (model 3) had the best fit in both networks (see Table 3). Goodness-of-fit statistics are displayed in Figure 3 and show satisfactory model fit for the final models. The gray 95% confidence interval displays the proportion of nodes with the respective characteristic (degree, edgewise-shared partners, triad census, or minimum geodesic distance) in the simulated networks based on the final ERGM (model 3). The black line represents the proportion of nodes with the respective characteristic in the observed networks.

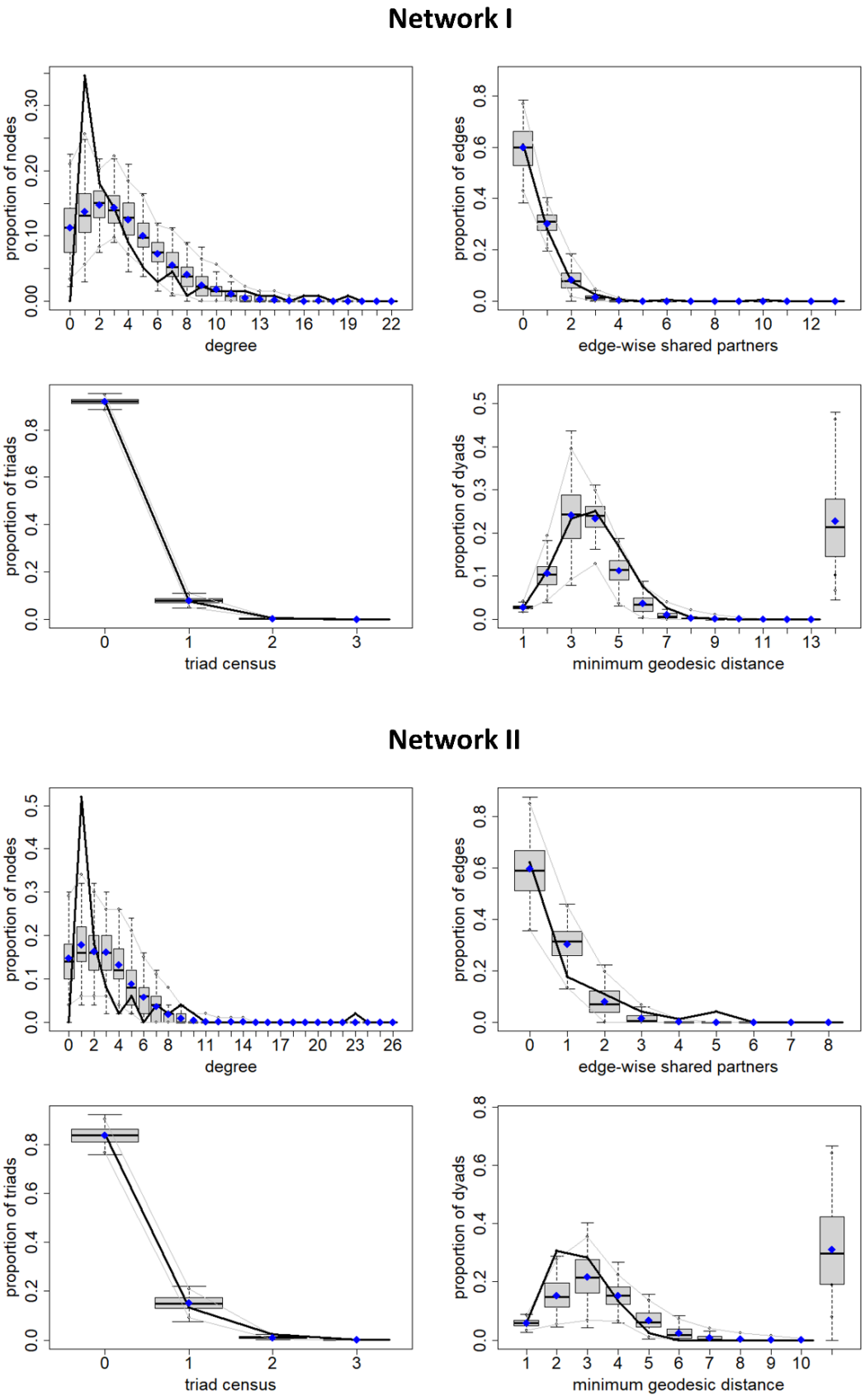


Figure 3: Goodness-of-fit for final Network I model and final Network II model. Gray 95% confidence interval displays proportion of nodes with the respective characteristic in the simulated networks based on the final ERGM, black line represents proportion of nodes with the respective characteristic in the observed networks

Discussion

The purpose of this study was to analyze interorganizational cooperation in community networks focused on sports and PA. By investigating two cooperation networks of community sports and PA providers as well as sports administrating and coordinating organizations, we identified structures and predictors that facilitate cooperation and which enable us to uncover starting points for strategic network development and network management in sport and PA promotion.

First, we examined the structural properties of the networks. In both networks, non-profit organizations – mainly sports clubs – made up the majority, while private for-profit organizations were the least represented. This is not surprising, given that cooperation between the private sector and the public or non-profit sector is generally challenging due to their different aims, values, and missions (Babiak & Thibault, 2009). However, since the integration of private organizations in public health networks is seen as particularly beneficial due to their resources and competencies (Christensen et al., 2019; Joudyian et al., 2021; Wiggins et al., 2021), strategies are needed to convince these actors of an engagement in sport and PA promotion. In addition to financial incentives, one approach could be to emphasize the opportunity of recruiting new members or clients through cooperation and joint projects. Another possible strategy would be to make for-profit organizations aware of the opportunity to engage in PA promotion as part of their corporate social responsibility efforts (Leone et al., 2016).

In line with a systems thinking approach, it is important to integrate change agents from various sectors into these types of networks whose primary focus is not on sports and PA promotion. Such change agents could be urban planners, transportation services, health insurance companies, or social service agencies (Rütten et al., 2019). They can have a major impact on PA-promoting structures but often do not realize that they play a crucial role (Brownson et al., 2010; Leone & Pesce, 2017; van Rinsum et al., 2017; Wolbring et al., 2021). By aligning community structures, PA promotion can be approached more holistically (World Health Organization, 2018). However, too much heterogeneity among different actor groups and sectors can also be a hindrance to network effectiveness (Vangen & Huxham, 2012), which should be considered when managing and developing these networks.

The analyzed networks had a low density with a small number of realized ties. Since both were not formally established and had not yet been subject to systematic management, this is not surprising and can also be observed in other networks of this type (Andrade et al., 2018; Seippel & Belbo, 2021). Previous studies showed that there is a need for closer cooperation and networking in the field of sport and PA promotion (Wäsche et al., 2018; Wolbring et al., 2021). The findings of this study provide evidence for this call for more integrated cooperation and strategic governance, as the observed networks were highly fragmented. Centralization tendencies could be identified in both networks but these were more pronounced in Network II. In both networks, the community sports administrations are among the most central network organizations, in terms of the number of cooperative ties and in terms of their function as bridging organizations. Previous studies also concluded that public and governmental sector organizations occupy a powerful position within public health networks (Andrade et al., 2018; Parra et al., 2011). This is probably because these organizations are responsible for the distribution of financial and material resources and the coordination of cooperation is inherently one of their main tasks.

Previous research has come to mixed conclusions about what level of network size, density, and centralization is ideal. The larger the network, the greater the variety of different goals of the individual organizations (Loitz et al., 2017). This represents a challenge regarding the effectiveness of a network to solve specific problems (Bevc et al., 2015). At the same time, especially in the observed networks, there is little public funding available. Thus, by integrating more actors and by forming more relationships between existing actors, there is greater availability of resources, expertise, ideas, and mutual trust, making positive outcomes more likely (Retrum et al., 2013). It has also been shown that increased exchange and cooperation can lead to improved dissemination of information within the network (Luke et al., 2013). For networks with a large number and diversity of actors to be effective, common network goals should be defined and documented, and their achievement should be monitored (Varda et al., 2012). Advantages of centralized networks are that one actor or a small group of key actors organize the network activities centrally and efficiently (Parra et al., 2011). Decentralized networks leave more room for diversity and the emergence of new ideas (Yessis et al., 2013). However, it is significantly more time-consuming for individual organizations to maintain a multitude of cooperative relationships (Loitz et al., 2017),

rather than to rely on a central organization to coordinate all activities. Because there is large variation in the goals and network engagement of the individual organizations surveyed, a centralized network form might therefore be more appropriate for managing cooperative activities (Provan & Kenis, 2007).

The second aim of this study was to identify organizational and structural predictors and conditions of cooperation in interorganizational community networks of sport and PA promotion. In both networks, non-profit sector organizations cooperated with each other less frequently than would have been expected by chance. Additionally, a heterophily effect was observed among public sector organizations in Network I. Thus, cooperation in the two networks is characterized by heterophilic rather than homophilic relationships and therefore occurs in intersectoral clusters. These findings are in accordance with resource dependence theory (Pfeffer & Salancik, 2009), which states that organizations establish heterophilic ties with other organizations to gain access to information and resources that are not available within their own sector. Previous research concludes that homophilic relationships are more common in public health (Bevc et al., 2015), yet the importance of cooperation in intersectoral clusters, in particular, is consistently emphasized. Cross-border cooperation, while more costly and difficult to manage, is thought to be more likely to help achieve structural change (Bornstein et al., 2013; Lasker et al., 2001; Meisel et al., 2014). In addition, the greater diversity of available resources allows for capacity building in interorganizational networks (Hambrick et al., 2019). In this respect, the heterophilic nature of cooperative ties in the studied networks can be seen as purposeful. However, it should be taken into account when managing the networks.

For-profit organizations did not show a higher level of cooperative activity, which could be attributed to the fact that they do not see any added value in increased network engagement. Furthermore, limited time and personnel resources as well as conflicting expectations regarding the objectives of cooperation could act as barriers for private-sector organizations (Babiak & Thibault, 2009). Here, again, strategies are needed to make the benefits of network participation clear to for-profit organizations. In Network II, owning a sports facility did not lead to more cooperative ties. A reason for this could be that organizations that own a sports facility are less dependent on cooperation. This is in accordance with resource dependence theory (Pfeffer & Salancik, 2009).

In terms of structural predictors, cooperation in both networks was characterized by triangular structures, indicating that network organizations often cooperated in small, group-like clusters, which are inherently characterized by reciprocity, trust, and information sharing (Brandenberger et al., 2019; Burt & Knez, 1995; Powell, 1990; Robins et al., 2012). This effect was also found in two previous studies analyzing networks of sport and PA promotion (Brownson et al., 2010; Meisel et al., 2014), and is suggestive of small networks within the network. Another structural mechanism that characterized cooperation in both networks was a centralization effect. It occurs when ties within a network are not equally distributed so that a few actors have formed more relationships than others (Barabasi, 1999; Hennig et al., 2012). These central actors, such as the community sports administrations, have a strong influence on network processes, whereupon other organizations also tend to establish cooperative ties with these central organizations, indicating a preferential attachment effect. The existence of a few important actors occupying a central position can also be observed in other informal networks or networks at an early stage of development (Buchthal et al., 2013; Wäsche, 2015). The power-law degree distribution in the observed networks with a few high-degree nodes and preferential attachment effects is similar to the organizing principles in scale-free networks as proposed by Barabási (Barabasi, 1999).

Taking the structure and mechanisms of cooperation in the observed networks into account, implications can be derived for effective network governance (Provan & Kenis, 2007; Wäsche & Gerke, 2019). Both networks have a low density and are centralized rather than decentralized. Because the networks were not formally established but have emerged unplanned without a strategic aim, there might be little consensus on network goals. Both networks are moderate to large in size, so the need for network-level competencies increases. However, when looking at a lower level, small triangular cooperative clusters characterized by high levels of mutual trust and interaction are also evident in both networks. Therefore, a hybrid of a lead organization- or leading group-governed network, where cooperation and information dissemination are centrally coordinated, and a participant-governed network, where the participants themselves manage the cooperation in smaller subgroups, might be the most effective governance form for both networks.

The major strength of this study is that it is one of only a few network studies in the field of public health and PA promotion (Andrade et al., 2018; Brownson et al., 2010;

Parra et al., 2011) that, in addition to describing network structures, also reveals the conditions and mechanisms of network functioning through stochastic network modeling procedures. From this, a variety of starting points for the development and management of community networks of sport and PA promotion can be uncovered. In addition, using the data of networks with similar characteristics (same type of network organizations, community-based, informal networks, same cultural area, federal state, etc.) allows for the consideration of more general characteristics and mechanisms of interorganizational cooperation and a better understanding of community sport and PA networks.

Nevertheless, the study has various limitations. The data collected are self-reported, which may be inherently subject to some degree of recall bias. In addition, some organizations did not participate in the survey despite multiple reminders, so not all cooperative relationships in the network may have been captured. However, we imputed missing data by symmetrization. Since this is a secondary analysis of existing data sets, the types of cooperation surveyed are not identical in both networks. This was counteracted by dichotomizing the data and combining all cooperation types. Furthermore, the data in both networks were not collected in the same year, but with a difference of five years. However, both networks were at a similar stage (no systematic management, not formally established), so comparability is still possible. Finally, the networks analyzed represent only a snapshot of the network organizations and relationships involved at the time of the survey. Nevertheless, studies like this are still the most common approach in network research as they can provide insights into the phenomena and characteristics of a newly developing research field.

Conclusions

This study adds to the body of knowledge on how interorganizational community networks of sport and PA promotion are structured and how they function. The analyzed networks showed various similar structural properties and mechanisms of network emergence. This knowledge allows to derive recommendations for their further development and management. Future research should focus on the evolution and dynamics of these networks in longitudinal studies to investigate whether existing structures are strengthened or weakened and which new actors get involved. To develop an overarching picture of structures and mechanisms in community networks of sports and PA

providers as well as sports administrating and coordinating organizations, further analyses of this kind are needed so that findings can be consolidated. In doing so, additional organizational and structural mechanisms, different types of exchange (e.g. access to economic resources or specialized knowledge), as well as barriers to cooperation, should be considered. Finally, cooperative efforts regarding sport and PA promotion should be encouraged through greater political support and public funding to facilitate population health benefits (McCartney et al., 2019).

References

An, R., Khan, N., Loehmer, E., & McCaffrey, J. (2017). Assessing the network of agencies in local communities that promote healthy eating and lifestyles among populations with limited resources. *American Journal of Health Behavior*, *41*(2), 127–138. https://doi.org/10.5993/AJHB.41.2.3

An, R., Loehmer, E., Khan, N., Scott, M. K., Rindfleisch, K., & McCaffrey, J. (2017). Community partnerships in healthy eating and lifestyle promotion: A network analysis. *Preventive Medicine Reports*, *6*, 294–301. https://doi.org/10.1016/j.pmedr.2017.03.007

Andrade, D. R., Garcia, L. M. T., & Perez, D. C. P. (2018). Local collaborations for physical activity promotion: A network analysis. *Cadernos De Saúde Pública*, *34*(10), Article e00127517. https://doi.org/10.1590/0102-311x00127517

Aubert, S., Barnes, J. D., Abdeta, C., Abi Nader, P., Adeniyi, A. F., Aguilar-Farias, N., Andrade Tenesaca, D. S., Bhawra, J., Brazo-Sayavera, J., Cardon, G., Chang, C.-K., Delisle Nyström, C., Demetriou, Y., Draper, C. E., Edwards, L., Emeljanovas, A., Gába, A., Galaviz, K. I., González, S. A., . . . Tremblay, M. S. (2018). Global matrix 3.0 physical activity report card grades for children and youth: Results and analysis from 49 countries. *Journal of Physical Activity & Health*, *15*(Suppl. 2), 251-273. https://doi.org/10.1123/jpah.2018-0472

Babiak, K., & Thibault, L. (2009). Challenges in multiple cross-sector partnerships. *Nonprofit and Voluntary Sector Quarterly*, *38*(1), 117–143. https://doi.org/10.1177/0899764008316054

Barabasi, A. (1999). Emergence of scaling in random networks. *Science*, *286*(5439), 509–512. https://doi.org/10.1126/science.286.5439.509

Barnes, M., MacLean, J., & Cousens, L. (2010). Understanding the structure of community collaboration: The case of one Canadian health promotion network.

Health Promotion International, *25*(2), 238–247. https://doi.org/10.1093/heapro/daq002

Bauman, A. E., Reis, R. S., Sallis, J. F., Wells, J. C., Loos, R. J. F., & Martin, B. W. (2012). Correlates of physical activity: Why are some people physically active and others not? *The Lancet*, *380*(9838), 258–271. https://doi.org/10.1016/S0140-6736(12)60735-1

Berardo, R., & Scholz, J. T. (2010). Self-organizing policy networks: Risk, partner selection, and cooperation in estuaries. *American Journal of Political Science*, *54*(3), 632–649. https://doi.org/10.1111/j.1540-5907.2010.00451.x

Bevc, C. A., Retrum, J. H., & Varda, D. M. (2015). New perspectives on the "silo effect": Initial comparisons of network structures across public health collaboratives. *American Journal of Public Health*, *105*(Suppl. 2), 230-235. https://doi.org/10.2105/AJPH.2014.302256

Borgatti, S. P., Everett, M. G., & Freeman, L. C. (2002). *Ucinet for windows: Software for social network analysis* (Version 6.721) [Computer software]. Analytic Technologies. http://www.analytictech.com/archive/ucinet.htm

Borgatti, S. P., Everett, M. G., & Johnson, J. C. (2018). *Analyzing social networks* (2nd edition). SAGE.

Bornstein, D. B., Carnoske, C., Tabak, R., Maddock, J., Hooker, S. P., & Evenson, K. R. (2013). Factors related to partner involvement in development of the US national physical activity plan, *19*(3, Suppl.), S8-S16. https://doi.org/10.1097/PHH.0b013e318284047d

Brandenberger, L., Casiraghi, G., Nanumyan, V., & Schweitzer, F. (2019). Quantifying triadic closure in multi-edge social networks. In ASONAM '19 (Chair), *Proceedings of the 2019 IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining*. https://doi.org/10.1145/3341161.3342926

Brandes, U., & Wagner, D. (2011). *Visone: Visual social networks* (Version 2.19) [Computer software]. University of Konstanz & Karlsruhe Institute of Technology. https://visone.ethz.ch/

Brownson, R. C., Parra, D. C., Dauti, M., Harris, J. K., Hallal, P. C., Hoehner, C., Malta, D. C., Reis, R. S., Ramos, L. R., Ribeiro, I. C., Soares, J., & Pratt, M. (2010). Assembling the puzzle for promoting physical activity in Brazil: A social network analysis. *Journal of Physical Activity and Health*, *7*(Suppl. 2), 242-252. https://doi.org/10.1123/jpah.7.s2.s242

Buchthal, O. V., Taniguchi, N., Iskandar, L., & Maddock, J. (2013). Assessing state-level active living promotion using network analysis. *Journal of Physical Activity and Health*, *10*(1), 19–32. https://doi.org/10.1123/jpah.10.1.19

Burt, R. S., & Knez, M. (1995). Kinds of third-party effects on trust. *Rationality and Society*, *7*(3), 255–292. https://doi.org/10.1177/1043463195007003003

Butterfoss, F. D., Goodman, R. M., & Wandersman, A. (1996). Community coalitions for prevention and health promotion: Factors predicting satisfaction, participation, and planning. *Health Education Quarterly*, *23*(1), 65–79. https://doi.org/10.1177/109019819602300105

Christensen, J. H., Bloch, P., Møller, S. R., Søgaard, C. P., Klinker, C. D., Aagaard-Hansen, J., & Bentsen, P. (2019). Health in All local Policies: Lessons learned on intersectoral collaboration in a community-based health promotion network in Denmark. *The International Journal of Health Planning and Management*, *34*(1), 216–231. https://doi.org/10.1002/hpm.2620

Ding, D., Lawson, K. D., Kolbe-Alexander, T. L., Finkelstein, E. A., Katzmarzyk, P. T., van Mechelen, W., & Pratt, M. (2016). The economic burden of physical inactivity: A global analysis of major non-communicable diseases. *The Lancet*, *388*(10051), 1311–1324. https://doi.org/10.1016/S0140-6736(16)30383-X

Drees, J. M., & Heugens, P. P. M. A. R. (2013). Synthesizing and extending resource dependence theory. *Journal of Management*, *39*(6), 1666–1698. https://doi.org/10.1177/0149206312471391

Fleuren, T., Thiel, A., & Frahsa, A. (2021). Identification of network promoters in a regional and intersectoral health promotion network: A qualitative social network analysis in Southern Germany. *International Journal of Environmental Research and Public Health*, *18*(16), Article 8372. https://doi.org/10.3390/ijerph18168372

Frieden, T. R., Dietz, W., & Collins, J. (2010). Reducing childhood obesity through policy change: Acting now to prevent obesity. *Health Affairs*, *29*(3), 357–363. https://doi.org/10.1377/hlthaff.2010.0039

Goodreau, S. M. (2007). Advances in exponential random graph (p*) models applied to a large social network. *Social Networks*, *29*(2), 231–248. https://doi.org/10.1016/j.socnet.2006.08.001

Goodreau, S. M., Handcock, M. S., Hunter, D. R., Butts, C. T., & Morris, M. (2008). A statnet tutorial. *Journal of Statistical Software*, *24*(9), 1–27.

Guthold, R., Stevens, G. A., Riley, L. M., & Bull, F. C. (2018). Worldwide trends in insufficient physical activity from 2001 to 2016: A pooled analysis of 358 population-based surveys with 1·9 million participants. *The Lancet Global Health*, *6*(10), e1077-e1086. https://doi.org/10.1016/S2214-109X(18)30357-7

Hambrick, M. E., Svensson, P. G., & Kang, S. (2019). Using social network analysis to investigate interorganizational relationships and capacity building within a sport for development coalition. *Sport Management Review*, *22*(5), 708–723. https://doi.org/10.1016/j.smr.2018.12.002

Hamer, M., O'Donovan, G., & Murphy, M. (2017). Physical inactivity and the economic and health burdens due to cardiovascular disease: Exercise as medicine. In J. Xiao (Ed.), *Exercise for cardiovascular disease prevention and treatment: From molecular to clinical, Part 1* (pp. 3–18). Springer Singapore. https://doi.org/10.1007/978-981-10-4307-9_1

Harris, J. K. (2014). *An introduction to exponential random graph modeling*. *Quantitative applications in the social sciences*. SAGE.

Harris, J. K., Luke, D. A., Burke, R. C., & Mueller, N. B. (2008). Seeing the forest and the trees: Using network analysis to develop an organizational blueprint of state tobacco control systems. *Social Science & Medicine*, *67*(11), 1669–1678. https://doi.org/10.1016/j.socscimed.2008.07.013

Heath, G. W., Parra, D. C., Sarmiento, O. L., Andersen, L. B., Owen, N., Goenka, S., Montes, F., & Brownson, R. C. (2012). Evidence-based intervention in physical activity: Lessons from around the world. *The Lancet*, *380*(9838), 272–281. https://doi.org/10.1016/S0140-6736(12)60816-2

Hennig, M., Brandes, U., Pfeffer, J [Jürgen], & Mergel, I. (2012). *Studying social networks: A guide to empirical research* (1st ed.). Campus Verlag. http://gbv.eblib.com/patron/FullRecord.aspx?p=1026766

Hunter, D. R. (2007). Curved exponential family models for social networks. *Social Networks*, *29*(2), 216–230. https://doi.org/10.1016/j.socnet.2006.08.005

Hunter, D. R., Goodreau, S. M., & Handcock, M. S. (2008). Goodness of fit of social network models. *Journal of the American Statistical Association*, *103*(481), 248–258. https://doi.org/10.1198/016214507000000446

Hunter, D. R., & Handcock, M. S. (2006). Inference in curved exponential family models for networks. *Journal of Computational and Graphical Statistics*, *15*(3), 565–583. https://doi.org/10.1198/106186006X133069

Hunter, D. R., Handcock, M. S., Butts, C. T., Goodreau, S. M., & Morris, M. (2008). Ergm: A package to fit, simulate and diagnose exponential-family models for networks. *Journal of Statistical Software*, *24*(3), nihpa54860. https://doi.org/10.18637/jss.v024.i03

Joudyian, N., Doshmangir, L., Mahdavi, M., Tabrizi, J. S., & Gordeev, V. S. (2021). Public-private partnerships in primary health care: A scoping review. *BMC Health Services Research*, *21*(1), Article 4. https://doi.org/10.1186/s12913-020-05979-9

Kaluzny, A. D., Zuckerman, H. S., & Rabiner, D. J. (1998). Interorganizational factors affecting the delivery of primary care to older Americans. *Health Services Research*, *33*(2, Pt. 2), 381–401.

Kohler, S., Helsper, N., Dippon, L., Rütten, A., Abu-Omar, K., Pfeifer, K., & Semrau, J. (2021). Co-producing an action-oriented framework for community-based physical activity promotion in Germany. *Health Promotion International*, *36*(Suppl. 2), ii93-ii106. https://doi.org/10.1093/heapro/daab159

Kok, G., Gottlieb, N. H., Commers, M., & Smerecnik, C. (2008). The ecological approach in health promotion programs: A decade later. *American Journal of Health Promotion*, *22*(6), 437–442. https://doi.org/10.4278/ajhp.22.6.437

Kwait, J., Valente, T. W., & Celentano, D. D. (2001). Interorganizational relationships among HIV/AIDS service organizations in Baltimore: A network analysis. *Journal of Urban Health*, *78*(3), 468–487. https://doi.org/10.1093/jurban/78.3.468

Lasker, R. D., & Weiss, E. S. (2003). Creating partnership synergy: The critical role of community stakeholders. *Journal of Health and Human Services Administration*, *26*(1), 119–139. https://www.jstor.org/stable/41288031

Lasker, R. D., Weiss, E. S., & Miller, R. (2001). Partnership synergy: A practical framework for studying and strengthening the collaborative advantage. *The Milbank Quarterly*, *79*(2), 179-205. https://doi.org/10.1111/1468-0009.00203

Leischow, S. J., & Milstein, B. (2006). Systems thinking and modeling for public health practice. *American Journal of Public Health*, *96*(3), 403–405. https://doi.org/10.2105/AJPH.2005.082842

Leone, L., Ling, T., Baldassarre, L., Barnett, L. M., Capranica, L., & Pesce, C. (2016). Corporate responsibility for childhood physical activity promotion in the UK. *Health Promotion International*, *31*(4), 755–768. https://doi.org/10.1093/heapro/dav051

Leone, L., & Pesce, C. (2017). From delivery to adoption of physical activity guidelines: Realist synthesis. *International Journal of Environmental Research and Public Health*, *14*(10), Article 1193. https://doi.org/10.3390/ijerph14101193

Levy, M. A., & Lubell, M. N. (2018). Innovation, cooperation, and the structure of three regional sustainable agriculture networks in California. *Regional Environmental Change*, *18*(4), 1235–1246. https://doi.org/10.1007/s10113-017-1258-6

Loitz, C. C., Stearns, J. A., Fraser, S. N., Storey, K., & Spence, J. C. (2017). Network analysis of inter-organizational relationships and policy use among active living organizations in Alberta, Canada. *BMC Public Health*, *17*(1), Article 649. https://doi.org/10.1186/s12889-017-4661-5

Luke, D. A., & Harris, J. K. (2007). Network analysis in public health: History, methods, and applications. *Annual Review of Public Health*, *28*, 69–93. https://doi.org/10.1146/annurev.publhealth.28.021406.144132

Luke, D. A., Harris, J. K., Shelton, S., Allen, P., Carothers, B. J., & Mueller, N. B. (2010). Systems analysis of collaboration in 5 national tobacco control networks. *American Journal of Public Health*, *100*(7), 1290–1297. https://doi.org/10.2105/AJPH.2009.184358

Luke, D. A., & Stamatakis, K. A. (2012). Systems science methods in public health: Dynamics, networks, and agents. *Annual Review of Public Health*, *33*, 357–376. https://doi.org/10.1146/annurev-publhealth-031210-101222

Luke, D. A., Wald, L. M., Carothers, B. J., Bach, L. E., & Harris, J. K. (2013). Network influences on dissemination of evidence-based guidelines in state tobacco control programs. *Health Education & Behavior*, *40*(1, Suppl.), S33–S42. https://doi.org/10.1177/1090198113492760

Lusher, D., Robins, G., & Koskinen, J. (Eds.). (2013). *Exponential random graph models for social networks: Theory, methods, and applications*. Cambridge University Press. https://doi.org/10.1017/CBO9780511894701

Mays, G. P., & Scutchfield, F. D. (2010). Improving public health system performance through multiorganizational partnerships. *Preventing Chronic Disease*, *7*(6), Article 116.

McCartney, G., Hearty, W., Arnot, J., Popham, F., Cumbers, A., & McMaster, R. (2019). Impact of political economy on population health: A systematic review of reviews. *American Journal of Public Health*, *109*(6), e1-e12. https://doi.org/10.2105/AJPH.2019.305001

McCullough, J. M., Eisen-Cohen, E., & Salas, S. B. (2016). Partnership capacity for community health improvement plan implementation: Findings from a social network analysis. *BMC Public Health*, *16*(1), Article 566. https://doi.org/10.1186/s12889-016-3194-7

McLeroy, K. R., Bibeau, D., Steckler, A., & Glanz, K. (1988). An ecological perspective on health promotion programs. *Health Education Quarterly*, *15*(4), 351–377. https://doi.org/10.1177/109019818801500401

Meisel, J. D., Sarmiento, O. L., Montes, F., Martinez, E. O., Lemoine, P. D., Valdivia, J. A., Brownson, R. C., & Zarama, R. (2014). Network analysis of Bogotá's Ciclovía Recreativa, a self-organized multisectorial community program to promote physical activity in a middle-income country. *American Journal of Health Promotion*, *28*(5), e127-e136. https://doi.org/10.4278/ajhp.120912-QUAN-443

Mulroy, E. A. (1997). Building a neighborhood network: Interorganizational collaboration to prevent child abuse and neglect. *Social Work*, *42*(3), 255–264. https://doi.org/10.1093/sw/42.3.255

Parra, D. C., Dauti, M., Harris, J. K., Reyes, L., Malta, D. C., Brownson, R. C., Quintero, M. A., & Pratt, M. (2011). How does network structure affect partnerships for promoting physical activity? Evidence from Brazil and Colombia. *Social Science & Medicine*, *73*(9), 1365–1370. https://doi.org/10.1016/j.socscimed.2011.08.020

Pfeffer, J [Jeffrey], & Salancik, G. R. (2009). *The external control of organizations: A resource dependence perspective*. Stanford Business Books.

Powell, W. W. (1990). Neither market nor hierarchy: Network forms of organization. *Research in Organizational Behavior*, *12*, 295–336.

Provan, K. G., Harvey, J., & Zapien, J. G. de (2005). Network structure and attitudes toward collaboration in a community partnership for diabetes control on the US-Mexican border. *Journal of Health Organization and Management*, *19*(6), 504–518. https://doi.org/10.1108/14777260510629706

Provan, K. G., & Kenis, P. (2007). Modes of network governance: Structure, management, and effectiveness. *Journal of Public Administration Research and Theory*, *18*(2), 229–252. https://doi.org/10.1093/jopart/mum015

Provan, K. G., Nakama, L., Veazie, M. A., Teufel-Shone, N. I., & Huddleston, C. (2003). Building community capacity around chronic disease services through

a collaborative interorganizational network. *Health Education & Behavior*, *30*(6), 646–662. https://doi.org/10.1177/1090198103255366

Provan, K. G., Veazie, M. A., Staten, L. K., & Teufel-Shone, N. I. (2005). The use of network analysis to strengthen community partnerships. *Public Administration Review*, *65*(5), 603–613. https://doi.org/10.1111/j.1540-6210.2005.00487.x

R Core Team. (2021). *R: A language and environment for statistical computing* (Version 4.0.5) [Computer software]. R Foundation for Statistical Computing. https://www.R-project.org/

Reiner, M., Niermann, C., Jekauc, D., & Woll, A. (2013). Long-term health benefits of physical activity - A systematic review of longitudinal studies. *BMC Public Health*, *13*(1), Article 813. https://doi.org/10.1186/1471-2458-13-813

Retrum, J. H., Chapman, C. L., & Varda, D. M. (2013). Implications of network structure on public health collaboratives. *Health Education & Behavior*, *40*(1, Suppl.), S13–S23. https://doi.org/10.1177/1090198113492759

Robins, G., Lewis, J. M., & Wang, P. (2012). Statistical network analysis for analyzing policy networks. *Policy Studies Journal*, *40*(3), 375–401. https://doi.org/10.1111/j.1541-0072.2012.00458.x

Robins, G., Pattison, P., Kalish, Y., & Lusher, D. (2007). An introduction to exponential random graph (p*) models for social networks. *Social Networks*, *29*(2), 173–191. https://doi.org/10.1016/j.socnet.2006.08.002

Robins, G., Snijders, T., Wang, P., Handcock, M., & Pattison, P. (2007). Recent developments in exponential random graph (p*) models for social networks. *Social Networks*, *29*(2), 192–215. https://doi.org/10.1016/j.socnet.2006.08.003

Roussos, S. T., & Fawcett, S. B. (2000). A review of collaborative partnerships as a strategy for improving community health. *Annual Review of Public Health*, *21*, 369–402. https://doi.org/10.1146/annurev.publhealth.21.1.369

Rütten, A., Abu-Omar, K., Messing, S., Weege, M., Pfeifer, K., Geidl, W., & Hartung, V. (2018). How can the impact of national recommendations for physical activity be increased? Experiences from Germany. *Health Research Policy and Systems*, *16*, Article 121. https://doi.org/10.1186/s12961-018-0396-8

Rütten, A., Frahsa, A., Abel, T., Bergmann, M., Leeuw, E. de, Hunter, D., Jansen, M., King, A., & Potvin, L. (2019). Co-producing active lifestyles as whole-system-approach: Theory, intervention and knowledge-to-action implications. *Health Promotion International*, *34*(1), 47–59. https://doi.org/10.1093/heapro/dax053

Rütten, A., & Pfeifer, K. (Eds.). (2016). *Nationale Empfehlungen für Bewegung und Bewegungsförderung*. FAU Erlangen-Nürnberg.

Rutter, H., Savona, N., Glonti, K., Bibby, J., Cummins, S., Finegood, D. T., Greaves, F., Harper, L., Hawe, P., Moore, L., Petticrew, M., Rehfuess, E., Shiell, A., Thomas, J., & White, M. (2017). The need for a complex systems model of evidence for public health. *The Lancet*, *390*(10112), 2602–2604. https://doi.org/10.1016/S0140-6736(17)31267-9

Sallis, J. F., Cervero, R. B., Ascher, W., Henderson, K. A., Kraft, M. K., & Kerr, J. (2006). An ecological approach to creating active living communities. *Annual Review of Public Health*, *27*, 297–322. https://doi.org/10.1146/annurev.publhealth.27.021405.102100

Sallis, J. F., Linton, L. S., Kraft, M. K., Cutter, C. L., Kerr, J., Weitzel, J., Wilson, A. L., Spoon, C., Harrison, I. D., Cervero, R., Patrick, K., Schmid, T. L., & Pratt, M. (2009). The Active Living Research program: Six years of grantmaking. *American Journal of Preventive Medicine*, *36*(2, Suppl.), S10-S21. https://doi.org/10.1016/j.amepre.2008.10.007

Schmidt, S. C. E., Anedda, B., Burchartz, A., Oriwol, D., Kolb, S., Wäsche, H., Niessner, C., & Woll, A. (2020). The physical activity of children and adolescents in Germany 2003-2017: The MoMo-study. *PloS One*, *15*(7), Article e0236117. https://doi.org/10.1371/journal.pone.0236117

Seippel, Ø., & Belbo, J. S. (2021). Sport clubs, policy networks, and local politics. *International Journal of Sport Policy and Politics*, *13*(3), 479–499. https://doi.org/10.1080/19406940.2021.1898441

Starkey, K., Barnatt, C., & Tempest, S. (2000). Beyond networks and hierarchies: Latent organizations in the U.K. television industry. *Organization Science*, *11*(3), 299–305. https://doi.org/10.1287/orsc.11.3.299.12500

Stuart, T. E. (2000). Interorganizational alliances and the performance of firms: A study of growth and innovation rates in a high-technology industry. *Strategic Management Journal*, *21*(8), 791–811. https://doi.org/10.1002/1097-0266(200008)21:8<791::AID-SMJ121>3.0.CO;2-K

Tausig, M. (1987). Detecting "cracks" in mental health service systems: Application of network analytic techniques. *American Journal of Community Psychology*, *15*(3), 337–351. https://doi.org/10.1007/BF00922702

Timm, I., Rapp, S., Jeuter, C., Bachert, P., Reichert, M., Woll, A., & Wäsche, H. (2021). Interorganizational networks in physical activity promotion: A systematic review. *International Journal of Environmental Research and Public Health*, *18*(14), Article 7306. https://doi.org/10.3390/ijerph18147306

Trochim, W. M., Cabrera, D. A., Milstein, B., Gallagher, R. S., & Leischow, S. J. (2006). Practical challenges of systems thinking and modeling in public health. *American Journal of Public Health*, *96*(3), 538–546. https://doi.org/10.2105/AJPH.2005.066001

Valente, T. W., Palinkas, L. A., Czaja, S., Chu, K.-H., & Brown, C. H. (2015). Social network analysis for program implementation. *PloS One*, *10*(6), Article e0131712. https://doi.org/10.1371/journal.pone.0131712

van Rinsum, C. E., Gerards, S., Rutten, G. M., van de Goor, I., & Kremers, S. (2017). Health brokers: How can they help deal with the wickedness of public health problems? *BioMed Research International*, *2017*, Article 1979153. https://doi.org/10.1155/2017/1979153

Vangen, S., & Huxham, C. (2012). The tangled web: Unraveling the principle of common goals in collaborations. *Journal of Public Administration Research and Theory*, *22*(4), 731–760. https://doi.org/10.1093/jopart/mur065

Varda, D. M., Chandra, A., Stern, S. A., & Lurie, N. (2008). Core dimensions of connectivity in public health collaboratives. *Journal of Public Health Management and Practice*, *14*(5), E1-7. https://doi.org/10.1097/01.PHH.0000333889.60517.46

Varda, D. M., Shoup, J. A., & Miller, S. (2012). A systematic review of collaboration and network research in the public affairs literature: Implications for public health practice and research. *American Journal of Public Health*, *102*(3), 564–571. https://doi.org/10.2105/AJPH.2011.300286

Wäsche, H. (2015). Interorganizational cooperation in sport tourism: A social network analysis. *Sport Management Review*, *18*(4), 542–554. https://doi.org/10.1016/j.smr.2015.01.003

Wäsche, H., Beecroft, R., Trenks, H., Seebacher, A., & Parodi, O. (2021). Transdisciplinary sport and physical activity development in urban real-world labs. *International Journal of Sports Marketing and Sponsorship*, *22*(4), 816–833. https://doi.org/10.1108/IJSMS-05-2020-0081

Wäsche, H., Dickson, G., Woll, A., & Brandes, U. (2017). Social network analysis in sport research: An emerging paradigm. *European Journal for Sport and Society*, *14*(2), 138–165. https://doi.org/10.1080/16138171.2017.1318198

Wäsche, H., & Gerke, A. (2019). Interorganisational network governance in sport. In M. Winand & C. Anagnostopoulos (Eds.), *Research Handbook on Sport Governance* (pp. 202–215). Edward Elgar Publishing. https://doi.org/10.4337/9781786434821.00021

Wäsche, H., Panter, L., Mehl, R., & Rapp, S. (2019). *Sport und Bewegung in der Karlsruher Oststadt : Ergebnisbericht.* Karlsruher Institut für Technologie (KIT). https://doi.org/10.5445/IR/1000089358

Wäsche, H., Peters, S., Appelles, L., & Woll, A. (2018). Bewegungsförderung in Deutschland: Akteure, Strukturen und Netzwerkentwicklung. *Bewegungstherapie & Gesundheitssport*, *34*(6), 257–273. https://doi.org/10.1055/a-0739-9857

Wäsche, H., Wolbring, L., & Woll, A. (2021). Physical activity promotion in an urban district: Analyzing the mechanisms of interorganizational cooperation. *PloS One*, *16*(11), Article e0260053. https://doi.org/10.1371/journal.pone.0260053

Wasserman, S., & Faust, K. (1994). *Social network analysis: Methods and applications*. Cambridge University Press. https://doi.org/10.1017/CBO9780511815478

Wiggins, B., Anastasiou, K., & Cox, D. N. (2021). A systematic review of key factors in the effectiveness of multisector alliances in the public health domain. *American Journal of Health Promotion*, *35*(1), 93–105. https://doi.org/10.1177/0890117120928789

Williams, B., & Hummelbrunner, R. (2011). *Systems concepts in action: A practitioner's toolkit*. Stanford Business Books.

Wolbring, L., Reimers, A. K., Niessner, C., Demetriou, Y., Schmidt, S. C. E., Woll, A., & Wäsche, H. (2021). How to disseminate national recommendations for physical activity: A qualitative analysis of critical change agents in Germany. *Health Research Policy and Systems*, *19*(1), Article 78. https://doi.org/10.1186/s12961-021-00729-7

Woll, A., Wäsche, H., & Haag, M. (2012). *Sportbericht Konstanz : Sportverhalten und Sportstrukturen*. Lit-Verl.

World Health Organization. (2018). *More active people for a healthier world: Global action plan on physical activity 2018-2030*. World Health Organization. https://www.who.int/publications/i/item/9789241514187

Yessis, J., Riley, B., Stockton, L., Brodovsky, S., & Sychowski, S. von (2013). Interorganizational relationships in the Heart and Stroke Foundation's Spark Together for Healthy Kids™: Insights from using network analysis. *Health Education & Behavior*, *40*(1, Suppl.), S43–S50. https://doi.org/10.1177/1090198113490724

Zwald, M. L., Eyler, A. A., Haire-Joshu, D., Handy, S. L., Harris, J. K., Moreland-Russell, S., & Brownson, R. C. (2019). Network influences on the development and implementation of active transportation policies in six U.S. Cities. *Preventive Medicine*, *118*, 176–183. https://doi.org/10.1016/j.ypmed.2018.10.026

Additional file 1 - Survey items for data collection

1. Network I

1.1 German version (original language)

Mit welchen Einrichtungen kooperieren Sie im Rahmen Ihres Sportangebots in Konstanz?

Bitte geben Sie an, mit welchen Einrichtungen (Sportvereine, freie Sportanbieter, sportverwaltende und -beratende Einrichtungen, Schulen, Kindergärten, Kirchen und Altenpflegeeinrichtungen) Sie im Rahmen Ihres Sportangebots kooperieren. Beziehen Sie sich dabei auf die Einrichtungen in nachfolgender Liste. Um die Liste zu betrachten, klicken Sie bitte auf den folgenden Hyperlink:

Liste der sportanbietenden und -verwaltenden Einrichtungen in Konstanz

Die Liste öffnet sich dann in einem neuen Fenster Ihres Browsers, während die Umfrage im Hintergrund geöffnet bleibt. Sie können bis zu zehn Einrichtungen nennen. Falls Sie mit mehr als zehn Einrichtungen kooperieren, nennen Sie nur die zehn wichtigsten. Beurteilen Sie für jede von Ihnen angeführte Einrichtung die Art der Kooperation:

- es findet lediglich ein Austausch von Informationen statt

- es findet eine informelle Zusammenarbeit statt (lose Zusammenarbeit um gemeinsame Ziele zu erreichen)
- es findet eine formelle Zusammenarbeit statt (enge Zusammenarbeit in einem Team um gemeinsame Ziele zu erreichen)
- es besteht eine Partnerschaft (enge Zusammenarbeit über einen längeren Zeitraum in verschiedenen Projekten)

	Austausch von Informationen	Informelle Zusammenarbeit	Formelle Zusammenarbeit	Partnerschaft
Name der Einrichtung:	□	□	□	□
Name der Einrichtung:	□	□	□	□
Name der Einrichtung:	□	□	□	□
Name der Einrichtung:	□	□	□	□
Name der Einrichtung:	□	□	□	□
Name der Einrichtung:	□	□	□	□
Name der Einrichtung:	□	□	□	□
Name der Einrichtung:	□	□	□	□
Name der Einrichtung:	□	□	□	□
Name der Einrichtung:	□	□	□	□

1.2 English version

With which organizations do you cooperate as part of your sports offerings in Constance?

Please indicate with which institutions (sports clubs, commercial sports providers, sports administrating and coordinating organizations, schools, kindergartens, churches, and old people’s homes) you cooperate as part of your sports offering in Constance. Refer to the organizations in the list below. To view the list, please click on the following hyperlink:

List of sports-providing and -administrating organizations in Constance.

The list will open in a new window in your browser while the survey remains open in the background. You can name up to ten organizations. If you cooperate with more than ten organizations, name only the most important ten. For each organization you name, rate the type of cooperation:

- there is only an exchange of information
- there is an informal cooperation (loose cooperation to achieve common goals)
- there is a formal cooperation (close collaboration in a team to achieve common goals)
- there is a partnership (close cooperation over a longer period of time in different projects)

	exchange of information	informal cooperation	formal cooperation	partnership
name of the organization:				
	□	□	□	□
name of the organization:				
	□	□	□	□
name of the organization:				
	□	□	□	□
name of the organization:				
	□	□	□	□
name of the organization:				
	□	□	□	□
name of the organization:				
	□	□	□	□
name of the organization:				
	□	□	□	□
name of the organization:				
	□	□	□	□
name of the organization:				
	□	□	□	□
name of the organization:				
	□	□	□	□

2. Network II

2.1 German version (original language)

2.1.1 Possession of sports facility

Verfügt Ihre Einrichtung über Sportstätten in der Oststadt?

Unter Sportstätten werden Sportanlagen (primär für den Sport geschaffen) oder Sportgelegenheiten (für andere Zwecke geschaffen, aber explizit dem Sport zur Verfügung stehende Räume, Plätze etc.) verstanden. Bitte geben Sie den Namen, Adresse, Art der Sportstätte sowie die jeweilige Größe in Quadratmetern (qm) an und ob sie für jedermann öffentlich zugänglich ist oder nicht. Berücksichtigen Sie dabei bitte, ob die Sportstätte im eigenen Besitz, zur Pacht oder in Pflege ist und machen Sie die Angaben im jeweiligen Feld.

	Name	Adresse	Art der Sportstätte	Größe in qm	Öffentlich zugänglich? (ja/nein)
im eigenen Besitz:					
im eigenen Besitz:					
im eigenen Besitz:					
zur Pacht/Miete:					
zur Pacht/Miete:					
zur Pacht/Miete:					
zur Pflege:					
zur Pflege:					
Zur Pflege:					

2.1.2 Identifying cooperation network

Mit welchen Einrichtungen kooperieren Sie im Rahmen Ihres Sportangebots in der Oststadt?

Bitte geben Sie an, mit welchen Einrichtungen (Schulen, Vereine, Kindergärten, freie Sportanbieter, Sportverwaltung, Kirchen und Altenpflegeeinrichtungen) Sie im Rahmen Ihres Sportangebots in der Oststadt kooperieren. Beziehen Sie sich dabei auf die Einrichtungen in nachfolgender Liste. Um die Liste zu betrachten, klicken Sie bitte auf den folgenden Hyperlink:

Liste der sportanbietenden und -verwaltenden Einrichtungen in oder mit Bezug zur Oststadt

Die Liste öffnet sich dann in einem neuen Fenster Ihres Browsers, während die Umfrage im Hintergrund geöffnet bleibt. Sie können bis zu zehn Einrichtungen nennen. Falls Sie mit mehr als zehn Einrichtungen kooperieren, nennen Sie nur die zehn wichtigsten. Beurteilen Sie für jede von Ihnen angeführte Einrichtung die Art der Kooperation (Mehrfachantworten sind möglich):

- es findet ein Austausch von Informationen statt
- es findet ein Austausch von Personal statt
- es findet eine Zusammenarbeit bei Sport- und Bewegungsangeboten statt
- es findet eine gemeinsame Nutzung von Sportstätten statt

	Austausch von Informationen	Austausch von Personal	Zusam-menarbeit bei Angeboten	Nutzung von Sportstätten
Name der Einrichtung:	◻	◻	◻	◻
Name der Einrichtung:	◻	◻	◻	◻
Name der Einrichtung:	◻	◻	◻	◻
Name der Einrichtung:	◻	◻	◻	◻
Name der Einrichtung:	◻	◻	◻	◻
Name der Einrichtung:	◻	◻	◻	◻
Name der Einrichtung:	◻	◻	◻	◻
Name der Einrichtung:	◻	◻	◻	◻
Name der Einrichtung:	◻	◻	◻	◻
Name der Einrichtung:	◻	◻	◻	◻

2.2 English version

2.2.1 Possession of sports facility

Does your organization have sports facilities in the Oststadt?

Sports facilities are understood to be sports facilities (primarily created for sports) or sports opportunities (rooms, places, etc. created for other purposes, but explicitly available for sports). Please indicate the name, address, type of sports facility as well as the respective size in square meters (sqm) and whether it is open to the public or not. Please take into account whether the sports facility is owned, leased or maintained and provide the information in the respective field.

	name	address	type of sports facility	size in sqm	open to the public? (yes/no)
in own possession:					
in own possession:					
in own possession:					
leased:					
leased:					
leased:					
for maintenance:					
for maintenance:					
for maintenance:					

2.2.2 Identifying cooperation network

With which organizations do you cooperate as part of your sports offerings in the Oststadt?

Please indicate with which institutions (schools, sports clubs, kindergartens, commercial sports providers, sports administration, churches and old people’s homes) you cooperate as part of your sports offering in the Oststadt. Refer to the organizations in the list below. To view the list, please click on the following hyperlink:

List of sports-providing and -administrating organizations in or related to the Oststadt.

The list will open in a new window in your browser while the survey remains open in the background. You can name up to ten organizations. If you cooperate with more than ten organizations, name only the most important ten. For each organization you name, rate the type of cooperation (multiple answers are possible):

- there is an exchange of information

- there is an exchange of personnel

- there is a cooperation in the provision of sports and physical activity programs

- there is a joint use of sports facilities

	exchange of information	exchange of personnel	cooperation on programs	use of sports facilities
name of the organization:				
	□	□	□	□
name of the organization:				
	□	□	□	□
name of the organization:				
	□	□	□	□
name of the organization:				
	□	□	□	□
name of the organization:				
	□	□	□	□
name of the organization:				
	□	□	□	□
name of the organization:				
	□	□	□	□
name of the organization:				
	□	□	□	□
name of the organization:				
	□	□	□	□
name of the organization:				
	□	□	□	□

Chapter 5: Socio-structural determinants of physical activity

Paper IV: Socio-structural determinants of physical activity behavior in children and adolescents: The importance of social support

Slightly modified version of the published paper

Wolbring, L., Jekauc, D., Hinz, T., Burchartz, A., Kolb, S., Schmidt, S. C. E., Woll, A., & Wäsche, H. (2024). Socio-structural determinants of physical activity behavior in children and adolescents: The importance of social support. *International Review for the Sociology of Sport*. https://doi.org/10.1177/10126902241266615

Abstract

Introduction: The purpose of this study is to analyze the influence and interplay of socio-structural determinants of health-related physical activity behavior in children and adolescents. We expected that socioeconomic status, social support, and physical environment influence physical activity directly while socioeconomic status also has an indirect influence via social support and physical environment. In addition, we hypothesized that social support has an indirect effect through the physical environment.

Methods: Cross-sectional data from the German Motorik-Modul study (MoMo) were used (Wave 2, 2014-2017). The sample consisted of N = 2,134 children and adolescents aged 6-17 years. Socioeconomic status (parental education, occupational status, and net income), social support, and physical environment were measured by questionnaires. To measure physical activity, children and adolescents were instructed to wear ActiGraphGT3X+/wGT3X-BT accelerometers for seven consecutive days. Moderate to vigorous activity periods were considered for the analysis. Path analyses were used to analyze the direct and indirect effects for children (6-10 years) and adolescents (11-17 years).

Results: Goodness-of-fit statistics showed satisfactory model fits for both models (children and adolescents). Among children, only social support had a direct effect on physical activity behavior. In addition, social support influenced the perceived physical environment. Socioeconomic status did not have a direct but an indirect effect on physical activity via social support. For adolescents, all assumed relations were significant and in line with the directions expected. Of the socio-structural determinants, social support

had the strongest direct influence on physical activity behavior and also indirectly influenced physical activity behavior via the physical environment. Socioeconomic status had a direct and indirect effect on physical activity via the physical environment and social support.

Conclusions: The results of this study emphasize the relevance of close, social networks of families and friends as well as social capital, as a source of social support, for physical activity levels among young age groups. Interventions to increase children's and adolescents' physical activity levels should thus focus on components of social support from family and peers.

Keywords

Social structure, Social inequality, Infrastructure, Social networks, Physical activity promotion, Sport

Introduction

Sport and physical activity (PA) are essential for children and adolescents to grow up healthy (Janssen & Leblanc, 2010). Being active prevents chronic illnesses, such as diabetes mellitus and cardiovascular disease (Archer, 2014; Twisk et al., 2002) but also mental health disorders (Archer, 2014). Apart from health aspects, exercise is beneficial for the motor, cognitive, social, and emotional development of children and adolescents (Bidzan-Bluma & Lipowska, 2018; Burdette & Whitaker, 2005; Li & Shao, 2022). In Germany, however, only about 19 percent of girls and boys achieve the PA guidelines of 60 minutes of moderate to vigorous physical activity (MVPA) everyday day recommended by the World Health Organization (Jekauc et al., 2012; Schmidt et al., 2020; World Health Organization, 2010).

In order to develop effective interventions to promote PA, it is important to investigate which factors influence the PA behavior of children and adolescents (Sallis et al., 2000; Schmidt et al., 2019). Social ecological models (Kok et al., 2008; Sallis et al., 2000) consider individual behavior as a product of multiple interacting factors and thereby account for the complexity and interdependence of these influences. Accordingly, various factors at the intrapersonal, interpersonal, organizational, community, and policy levels influence whether and how physically active a person is. Previous research on the determinants of health behaviors like PA has shown that apart from individual

aspects, structural factors, such as social and environmental conditions, in particular, can explain inequalities in PA behavior among children and adolescents (Sallis et al., 2000; Schmidt et al., 2019).

From a sociological perspective, there are various dimensions of societal structures (Esser, 1999), representing opportunities and restrictions for individuals. Three of them have been recently considered in the context of sport and PA promotion (Wäsche, 2022): the institutional structure, the social structure, and the infrastructure. The basic assumption here is that individuals act within and form these structures but are also significantly influenced by them. In our definition of societal structures, we refer to Esser (1999). Accordingly, the institutional structure contains the sum of social norms and values. The social structure comprises the relationship structure, as the sum of permanently established relationships between the actors of society, also often referred to as social networks and social capital (Putnam, 2001; Wäsche et al., 2017), and the structures of social inequality, which can be seen as an indicator for the distribution of social resources. The infrastructure represents the material basis of a society such as roads, railways, cities, energy networks, or facilities for production, education, sport, and leisure. Esser (1999) also refers to the superstructure, comprising overarching worldviews and beliefs, which influences the mentioned structures but plays only a subordinate role in the following.

Regarding these structural dimensions, three determinants are frequently studied regarding the PA behavior of children and adolescents: The socioeconomic status (SES) (as related to the structures of social inequality) (Biddle et al., 2011), social support from family and friends (as related to the relationship structure) (Mendonça et al., 2014; Prochnow et al., 2023), and the physical environment in which children and adolescents live, play, and learn (as related to the infrastructure) (Sterdt et al., 2014). It has been shown that children and adolescents whose parents have a high SES are more physically active than children and adolescents from families with a low SES (Andersen & Bakken, 2019; Rittsteiger et al., 2021; Tandon et al., 2021). Also, children and adolescents who are supported by their parents and peers in their PA behavior do more sport than children and adolescents who receive little support in this regard (Beets et al., 2010; Camargo et al., 2023; Fitzgerald et al., 2012; Reimers et al., 2019). In addition, a residential environment in which sufficient opportunities for PA are available can

have a positive influence on the PA behavior of children and adolescents (Ding et al., 2011; Pate et al., 2019; Young et al., 2014).

Referring back to the social ecological model, it is important not to look at the individual determinants separately but to consider their interactions since some relationships only become visible through the interplay of various factors (Biddle et al., 2011). The assumed relations of this study are displayed in Figure 1. Apart from a direct influence of SES, social support, and physical environment on the PA behavior of children and adolescents, we expect some indirect influences: First, children and adolescents whose parents have a high SES may live in environments that have more sports facilities and higher safety standards (Bolte et al., 2010; Molina-García et al., 2017). Second, in families with high SES, there may be more awareness of the benefits of PA as well as financial resources available for children and adolescents to be supported in their PA, resulting in higher sport participation (Eime et al., 2013; George et al., 2019; van Leeuwen et al., 2022). Third, children and adolescents who are supported by their family and peers to be physically active may be more aware of sports opportunities in their surroundings which in turn enhances their PA participation (Colabianchi et al., 2019; Loh et al., 2019). Since PA significantly differs by age and sex (Sterdt et al., 2014), they are added as control variables.

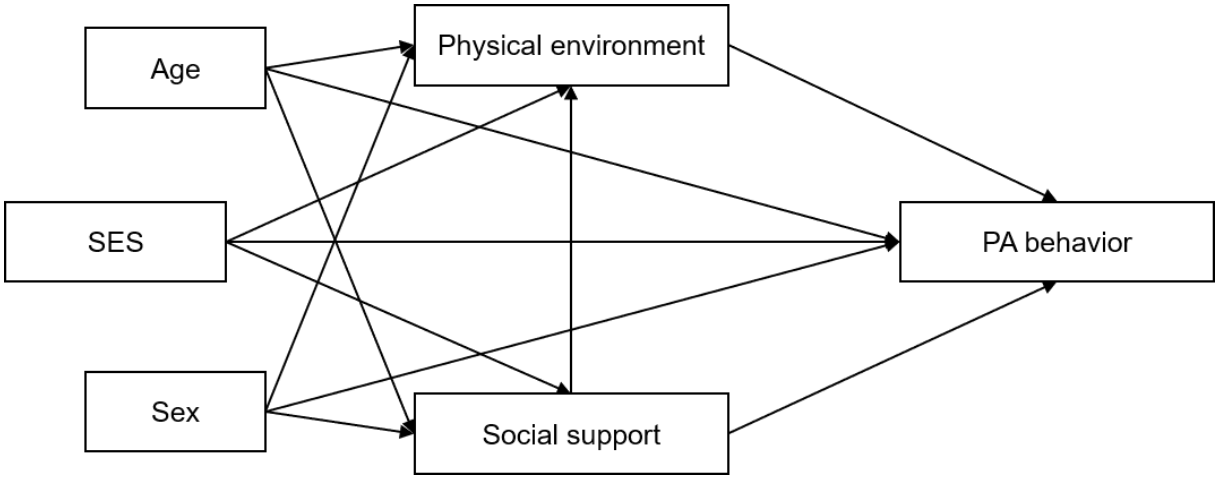


Figure 1: Assumed relations of the socio-structural determinants of physical activity behavior. SES = Socioeconomic status; PA = Physical activity

The contribution of this study to current research is threefold: First, we look in more detail at the direct *and* indirect influences of socio-structural factors on the PA behavior of children and adolescents. Second, and in contrast to previous research which has frequently relied on self-reported measures of PA (Nigg et al., 2020), we used device-based measurement methods as they can more reliably depict actual PA (Burchartz, Anedda, et al., 2020; Slootmaker et al., 2009). Third, since age may play a role in the extent to which SES, social support, and physical environment influence PA behavior (Biddle et al., 2011; Ding et al., 2011; Lau et al., 2016), we considered the socio-structural influences separately for children and adolescents. The results help to gain reliable information on how to develop effective measures and interventions to enhance PA in young age groups by taking socio-structural determinants into account.

Methods

Sampling and procedure

Data from the Motorik-Modul study (MoMo) were used which is a subsample of the German Health Interview and Examination Survey for Children and Adolescents (KiGGS). MoMo examines the associations between physical fitness, health, and PA levels in a representative sample of children and adolescents living in Germany by combining a cohort design with a longitudinal design (Woll et al., 2017). Until now, four waves of data collection have been conducted: baseline (2003-2005), wave 1 (2009-2012), wave 2 (2014-2017), and wave 3 (2018-2022). In each wave, panelists participated repeatedly and new cohorts of children and adolescents aged from four to 17 years were added. During each wave, a nationwide, stratified, multi-stage sample was drawn in three stages. First, 167 sample points, stratified according to their level of urbanization and geographic distribution (BIK classification system), were selected from an inventory of German communities. Second, an age-stratified sample of randomly selected children and adolescents was drawn from the official directories of local residents forming the KiGGS study sample (Kurth et al., 2008). Third, children and adolescents aged 4-17 years from the KiGGs study sample were randomly selected to form the MoMo subsample for each wave. The study was approved by the Charité Universitätsmedizin Berlin ethics committee and the Federal Office for the Protection of Data and was conducted in accordance with the Declaration of Helsinki.

For this study, we used cross-sectional data from MoMo wave 2 (total n = 3,708). We could not include data from the baseline and wave 1 because PA behavior was measured only by self-report data. Due to dropout for non-agreement and technical reasons (detailed information can be found in Burchartz, Manz, et al. (2020)), device-based measured PA data was available for 2,328 subjects.

Measures

The SES score is a composite of parental education, occupational status, and net income of the household. Each dimension can be assigned 1-7 points so that the total score ranges between three and 21. To calculate the SES score, the respective highest values of the educational and occupational status of either the mother or the father and the score for the net income of the household are summed up (Lampert et al., 2014). For the analysis, we divided the metric SES score into five quintiles.

Social support regarding PA was measured by a scale consisting of eight items covering parental support (PAS) (5 items) and peer support (PES) (3 items). The items were answered on a four-point rating scale. We built a social support index from the individual items by summing up the responses and dividing them by eight (number of items). The higher the index, the higher the participant's perception of parental and peer support. The items and rating scales are displayed in Table 1.

Table 1: Items of social support and physical environment scales (Reimers et al., 2012)

Social support items	**Rating scale**
1. Do your parents support you in your sports activity (e.g. by buying sporting goods for you)? (PAS)	(1) never, (2) rarely, (3) often, (4) always
2. How important is it for your parents that you do sport? (PAS)	(1) not important al all, (2) a little important, (3) pretty important, (4) very important
3. How much of an interest do your parents have in your sport? (PAS)	(1) none at all, (2) a little bit, (3) pretty strong, (4) very strong
4. How often is your sport a topic of conversation in your family? (PAS)	(1) never, (2) rarely, (3) often, (4) always

5. How often do your parents watch you doing sport? (PAS)	(1) never, (2) rarely, (3) often, (4) always
6. How often do you do sport with your friends? (PES)	(1) never, (2) rarely, (3) often, (4) always
7. How often do you ask your friends if they want to play outside or do sport with you (e.g. playing soccer, riding a bicycle, inline skating)? (PES)	(1) never, (2) rarely, (3) often, (4) always
8. How often do your friends ask you if you want to play or do sport with them (e.g. playing soccer, riding a bicycle, inline skating)? (PES)	(1) never, (2) rarely, (3) often, (4) always
Physical environment items	**Rating Scale**
1. In the area I live in, there are sports clubs. (ARF)	(1) none, (2) few, (3) several, (4) many
2. In the area I live in, there are commercial sport providers (e.g. fitness clubs). (ARF)	(1) none, (2) few, (3) several, (4) many
3. In the area I live in, there are sports facilities that are always accessible (e.g. soccer fields). (ARF)	(1) none, (2) few, (3) several, (4) many
4. In the area I live in, there are playgrounds. (ARF)	(1) none, (2) few, (3) several, (4) many
5. In the area I live in, shops and businesses can be reached on foot. (C)	(1) very badly, (2) rather badly, (3) rather well, (4) very well
6. From where I live, the bus and tram stops can be reached on foot. (C)	(1) very badly, (2) rather badly, (3) rather well, (4) very well
7. How safe are the public leisure time facilities in the area you live in (in terms of problems with crime)? (S)	(1) very unsafe, (2) pretty unsafe, (3) pretty safe, (4) very safe
8. For walking and riding a bicycle, the area I live in is …(S)	(1) not very nice at all, (2) not that nice, (3) pretty nice, (4) very nice

PAS = Parental support; PES = Peer support; ARF = Accessibility of recreation facilities; C = Convenience; S = Safety

Physical environment was measured on a scale consisting of eight items that covered the accessibility of recreation facilities (ARF) (4 items), convenience (C) (2 items), and safety (S) (2 items) of the residential environment. The items were answered on a four-point rating scale. We built a physical environment index by summing up the answers to the individual items and dividing them by eight (number of items). The higher the index, the higher the perception of a PA friendly environment. The items and rating scales are also displayed in Table 1.

A study testing the social support and physical environment scale found satisfying results for construct validity and reliability of the two scales (Reimers et al., 2012).

To measure PA, ActiGraphGT3X+/wGT3X-BT accelerometers (Actigraph, LLC, Pensacola, FL, USA) were used. Technical and methodological details of the assessment are described elsewhere (Burchartz, Manz, et al., 2020; Burchartz et al., 2021). Subjects from the age of six to 17 years were instructed to wear the accelerometers for seven consecutive days during waking hours. Data were considered valid if the device was worn for at least eight hours on four weekdays and one weekend day. We included the daily MVPA minutes in the analysis.

Individual attributes measured were age and sex, with girls coded 0 and boys coded 1.

Data analysis

Data were analyzed using IBM SPSS version 28.0 (IBM Corp., 2021) and AMOS version 28.0 (Amos Development Corp., 2021).

We used descriptive statistics to analyze all variables and confirmed correlations between the variables using the Pearson correlation coefficient.

We utilized path analysis, a specific type of structural equation modeling, to test the theoretically built model and calculate the path coefficients. This analysis is a powerful method to simultaneously consider the direct and indirect influences of various factors, consistent with the idea of social ecological models (Kline, 2016; Santiago-Torres et al., 2016).

Exogenous variables were SES, age, and sex. Endogenous variables were physical environment, social support, and PA behavior. Normality assessment of all variables

revealed no significant deviations from the multivariate normal distribution. We analyzed two models by using the full maximum likelihood estimation, one for children (6-10 years) and one for adolescents (11-17 years). Chi-square test, root mean square error of approximation (RMSEA), and comparative fix index (CFI) were used to examine how well the data fit the models. An insignificant *p*-value for the chi-square statistic, a RMSEA of ≤ .06, and a CFI of ≥ .95 are considered to indicate a good fit of the hypothesized model to the observed data (Barrett, 2007; Hooper et al., 2008; Hu & Bentler, 1999). In all analyses performed, *p* values < .05 were considered statistically significant.

Due to model non-convergence, we analyzed patterns of missing data. Cases with missing data for the variables social support and SES were deleted listwise due to unit nonresponse, resulting in 2,157 cases. The analysis of missing data for the physical environment variable did not reveal a consistent pattern (individual item nonresponse). Therefore, missing values for this variable were estimated using the expectation-maximization algorithm. There were no significant discrepancies between the estimated means and the means of all values. After restricting the sample to children and adolescents aged 6-17 years, the final sample consisted of *N* = 2,134 participants, of whom *N* = 676 were children aged 6-10 years and *N* = 1,458 were adolescents aged 11-17 years.

Results

Descriptives

Of the children aged 6-10, 49.7 % were girls and 50.3 % were boys, respectively. The sample of adolescents aged 11-17 years consisted of 54.4 % girls and correspondingly 45.6 % boys. The means, standard deviations, and confidence intervals for the means of the remaining variables for the two age groups are displayed in Table 2. The daily MVPA minutes by age and sex are displayed in Figure 2.

Table 2: Means, standard deviations, and 95% confidence intervals of study variables

	Children (*N* = 676)		Adolescents (*N* = 1,458)	
	Mean (SD)	**95%-CI**	**Mean (SD)**	**95%-CI**
Age	7.97 (1.41)	7.87-8.08	13.80 (1.94)	13.70-13.90
SES (quintiles)	3.61 (1.27)	3.52-3.71	3.43 (1.26)	3.36-3.49
Social support	3.03 (0.44)	2.99-3.06	2.71 (0.50)	2.69-2.74
Physical environment	2.82 (0.44)	2.78-2.85	2.89 (0.44)	2.87-2.91
Daily MVPA minutes	66.89 (23.81)	65.09-68.69	44.30 (20.02)	43.27-45.33

SD = Standard deviation; CI = Confidence interval; SES = Socioeconomic status; MVPA = Moderate to vigorous physical activity

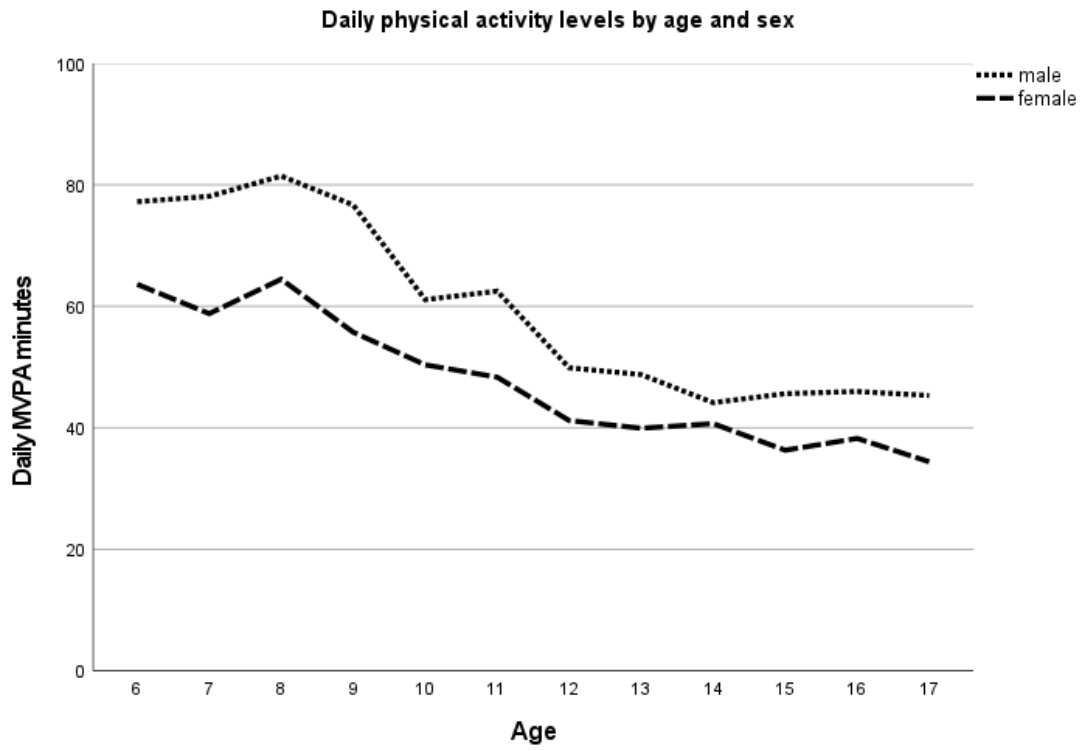


Figure 2: Daily physical activity levels by age and sex. MVPA = Moderate to vigorous physical activity

The correlations between the variables of interest are presented in Table 3 for children and adolescents, respectively. In both age groups, the correlations show similar patterns that are mostly consistent regarding the hypothesized model. However, as

opposed to adolescents, children's PA behavior was not significantly correlated to SES and physical environment. The correlations range from small to moderate.

Table 3: Correlation matrix of study variables for children (6-10 years) and adolescents (11-17 years)

Children					
	Social support	**Physical environment**	**Age**	**Sex**	**PA behavior**
SES	0.201**	0.256**	0.051	-0.002	0.051
Social support	-	0.231**	0.015	0.088*	0.185**
Physical environment	-	-	0.038	-0.015	0.042
Age	-	-	-	-0.018	-0.186**
Sex	-	-	-	-	0.352**
Adolescents					
	Social support	**Physical environment**	**Age**	**Sex**	**PA behavior**
SES	0.111**	0.141**	-0.055*	0.006	0.082**
Social support	-	0.204**	-0.316**	0.127**	0.229**
Physical environment	-	-	0.055*	-0.032	0.076**
Age	-	-	-	-0.043	-0.216**
Sex	-	-	-	-	0.233**

*$p < 0.05$; **$p < 0.01$; SES = Socioeconomic status; PA = Physical activity

Path analysis

Children

The results of the path analysis for children aged 6-10 years are presented in Figure 3. Of the socio-structural determinants examined, only social support had a significant

direct effect on PA behavior (β = 0.15, p < .001). In addition, social support significantly influenced the perceived physical environment (β = 0.19, p < .001). SES had an indirect effect on PA behavior via social support (β = 0.20, p < .001) but only a small and non-significant direct effect. Furthermore, SES had a significant effect on physical environment (β = 0.22, p < .001), which in turn had no significant effect on PA behavior. The largest effect in the entire model was for the influence of sex on PA behavior (β = 0.34, p < .001), indicating that boys engaged in nearly 16 minutes more MVPA per day than girls. Sex also significantly influenced social support (β = 0.09, p < .05) with boys perceiving more social support for sport and PA from family and friends than girls.

When examining the goodness of fit indices, the chi-square statistic did not deviate from zero (χ^2 = 1.98; df = 3; $p \geq 0.05$) and CFI (1.00) and RMSEA (0.00) indicated an almost perfect model fit.

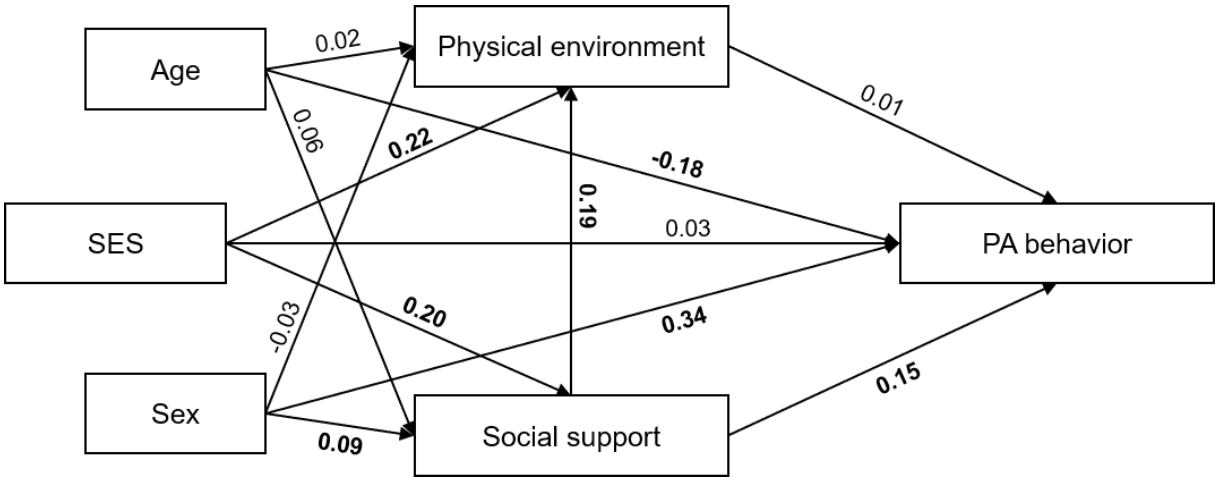


Figure 3: Results for socio-structural determinants of physical activity in children (6-10 years). Standardized regression weights are presented next to the arrows. Significant values with p < 0.05 are marked in bold. SES = Socioeconomic status; PA = Physical activity

Adolescents

For adolescents, all hypothesized relationships were significant. Among the socio-structural determinants, social support had the strongest direct effect on PA behavior (β = 0.13, p < .001) and also influenced PA behavior indirectly via the physical environment (β = 0.24, p < .001). SES had a direct effect (β = 0.05, p < .05) and indirect effect on PA behavior via the physical environment (β = 0.13, p < .001) and social

support (β = 0.09, p < .001). Among adolescents, boys perceived more social support for sport and PA than girls (β = 0.11, p < .001). In contrast, they perceived their environment as less PA friendly than girls (β = -0.06, p < .05). Similar to children, adolescent boys engaged in approximately 8.5 minutes more MVPA per day than adolescent girls. With increasing age, adolescents perceived their environment as more PA friendly (β = 0.14, p < .001). However, perceived social support for PA and sport from friends and family decreased with age (β = -0.31, p < .001).

When examining the goodness of fit indices, the chi-square statistic did not deviate from zero (χ^2 = 7.18; df = 3; $p \geq 0.05$) and CFI (0.99) and RMSEA (0.03) indicated a good model fit.

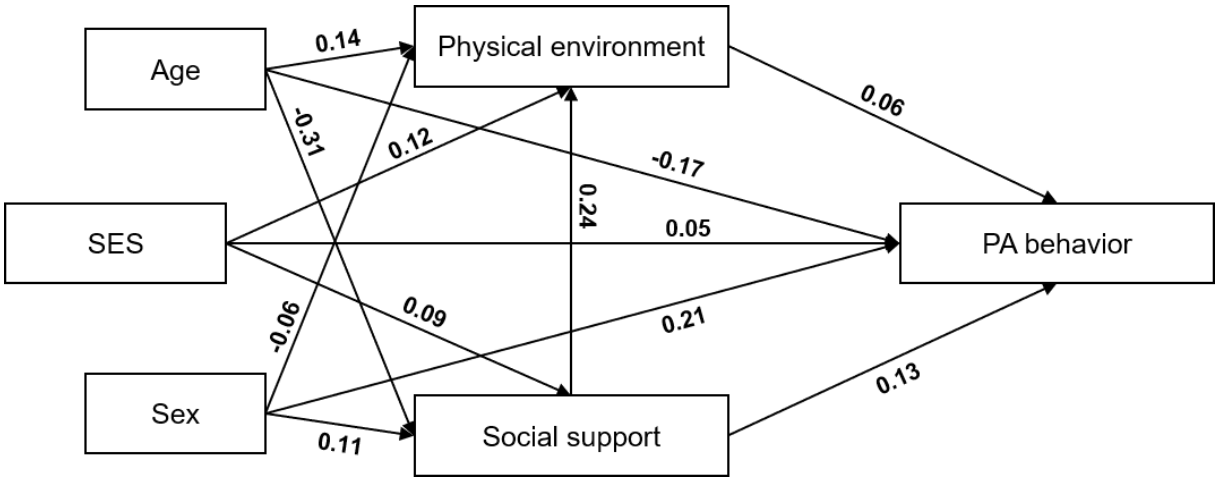


Figure 4: Results for socio-structural determinants of physical activity in adolescents (11-17 years). Standardized regression weights are presented next to the arrows. Significant values with p < 0.05 are marked in bold. SES = Socioeconomic status; PA = Physical activity

Discussion

The purpose of this study was to analyze the direct and indirect influences of the socio-structural determinants SES, social support, and physical environment on the PA behavior of children and adolescents.

The findings of this study indicate that the influence of SES on PA behavior varies across different age groups. Among children, there appears to be no direct impact of SES on PA behavior. For adolescents, the direct effect of SES on PA behavior is relatively small. In contrast to previous studies that found significant differences in SES-

related disparities between organized sports participation and unorganized PA (Andersen & Bakken, 2019; Rittsteiger et al., 2021), our study found that children aged 6-10 years had similar activity levels using device-based measures of PA across settings, regardless of their parents' SES. This suggests that high parental SES does not necessarily lead to higher PA levels in this age group. Nevertheless, as hypothesized, SES indirectly influenced PA behavior through social support for both children and adolescents. Our results indicate that children and adolescents from families with higher parental SES receive more support from their family and peers, which positively impacts their PA behavior and leads to increased activity levels. This indirect influence was more pronounced among children compared to adolescents, highlighting the crucial role of social inequalities and parental influence on PA behavior, especially in younger age groups (Drenowatz et al., 2010; Rhodes et al., 2020).

In addition to social support, SES also influenced children's and adolescents' perceptions of their physical environment. This is consistent with our assumption that individuals whose parents have a higher SES tend to reside in environments with more sports facilities and higher safety standards. (Bolte et al., 2010; Molina-García et al., 2017). These environmental factors were found to be more influential regarding the PA behavior among adolescents compared to children. Adolescents, being more independent and having a larger mobility radius, may have a better awareness of the PA-friendliness of their physical surroundings, which influences their PA levels. They can take advantage of PA opportunities in their neighborhoods, such as commuting to school, visiting friends, or engaging in leisure activities independently (Schoeppe et al., 2013; Shaw et al., 2015).

In sum, SES may only have a small direct effect but shows a double indirect effect via social support and physical environment on the PA behavior of adolescents. The indirect effect via social support is also evident for children. To promote PA among socially disadvantaged groups, specific low-threshold offers are needed at the community level that are inviting and accessible, especially for this target group (Tandon et al., 2021). Community cooperation networks of local sports, youth, health, and social organizations that are aware of the needs of the relevant population groups and jointly develop suitable offers can be a good starting point for tackling structures of social inequality (Dobbels et al., 2018; Wäsche et al., 2021; Wolbring et al., 2022).

Based on our results, social support was the only socio-structural determinant that had a direct effect on PA behavior in both age groups (Jekauc et al., 2019). The importance of social support compared to other determinants of children's and adolescents' built and social environment was also found in previous studies (Fritsch et al., 2023; Prochnow et al., 2023). Especially when considering device-based measures of PA, social support was the most consistent determinant of PA behavior (Sallis et al., 2002)

Referring back to the dimensions of structural factors influencing individuals and their behavior (Esser, 1999), interventions to enhance the PA levels in young age groups should address the social structure and, in particular, the relationship structure in which children and adolescents are embedded. Social support evolves from networks of social relations characterized by mutual support and acknowledgment, also referred to as social capital (Bourdieu, 1986; Ryan et al., 2008). In addition to social support, other forms of social capital include access to relevant information and economic resources (Schulz et al., 2017). Previous research has shown that high levels of social capital can even compensate for socioeconomic disadvantage (Coleman, 2000; Putnam, 2001) and physical environmental factors (Alfonzo, 2005) in the context of health and PA which is in line with our study results. While social and emotional support from close relationships with family and friends is defined as "bonding" social capital, formal relationships with other social groups to attain information are defined as "bridging" social capital (Putnam, 2001). If children and adolescents are embedded in social networks with high levels of PA among network members, they are also more active themselves (de la Haye et al., 2011; Prochnow et al., 2020). Thus, network-based approaches to further investigate "bonding" social capital as a determinant of PA could be helpful to further understand the underlying mechanisms. Our results show that boys perceive more social support than girls. To achieve gender equality, it would be particularly important to identify how girls can benefit from the advantages of social capital as a source of social support in terms of their PA behavior.

Social support from family and peers also influenced both children's and adolescents' perceptions of the physical environment. Thus, if children and adolescents receive support regarding their PA behavior, they also have a better perception of the PA friendliness of their environments. There is some evidence regarding the interaction between social and built environments when it comes to PA behavior (Colabianchi et al., 2019; Loh et al., 2019). However, a recent review also found inconsistent

associations between these two determinants (Prochnow et al., 2023). The results of our study provide further evidence that the perceptions of the residential environment are socially determined. This is in line with the approach of Lefebvre (1991) and Löw (2016) who do not see the infrastructure of a society as objectively given but as socially constructed. Accordingly, spaces do not exist independently of the members of a society, but are the product of their actions and relationships with each other.

Among all variables, age and sex had the largest effect on PA behavior for both age groups. The importance of these two variables with regard to PA levels of children and adolescents has also been shown in previous studies (Sterdt et al., 2014). However, as we aimed to investigate the direct and indirect influences of socio-structural factors on the PA behavior of children and adolescents, our focus is on these variables, while individual attributes such as age and sex are seen as control variables.

One of the major strengths of our study is the large sample size of a nationally representative cohort, which allowed us to analyze the interplay of individual socio-structural determinants in relation to the PA behavior in children and adolescents. Furthermore, in contrast to many other studies, we did not measure PA levels through self-report survey methods, but through objective device-based measurement methods. This allowed us to more reliably reflect the actual PA behavior of children and adolescents across settings (Burchartz et al., 2021; Slootmaker et al., 2009). However, some limitations should be mentioned. While PA behavior was measured device-based, the rest of the data collected is self-reported, which may inherently be subject to some degree of recall bias. In particular, the physical environment could be assessed objectively. However, subjectively collected data, as in our study, provide a more comprehensive picture of how the environment is perceived and experienced (Bittencourt et al., 2015; Lin & Moudon, 2010). Another limitation is that we are dealing with cross-sectional data collected at a single survey time point, so no causal conclusions can be drawn from on the results.

Conclusions

This study contributes to current research by providing more insights into the direct and indirect effects of socio-structural determinants on the PA behavior in children and adolescents. The analysis can help to gain reliable information on how to develop effective measures and interventions to enhance PA by taking these influential factors

into account. In particular, our results emphasize the importance of social support evolving from close family and friendship networks, also referred to as bonding social capital, for PA levels among young age groups. Interventions aimed at increasing PA levels in children and adolescent should therefore focus on components of social support from family and peers. Structures of social inequality played an indirect role regarding the PA behavior in both age groups. In order to create equal health opportunities, appropriate policies and services at the level of the physical environment and social integration are needed to enable socially disadvantaged children and adolescents to participate in sport and PA.

References

Alfonzo, M. A. (2005). To walk or not to walk? The hierarchy of walking needs. *Environment and Behavior*, *37*(6), 808–836. https://doi.org/10.1177/0013916504274016

Amos Development Corp. (2021). *IBM SPSS Amos for Windows* (Version 28.0) [Computer software]. IBM. https://www.ibm.com/de-de/products/structural-equation-modeling-sem

Andersen, P. L., & Bakken, A. (2019). Social class differences in youths' participation in organized sports: What are the mechanisms? *International Review for the Sociology of Sport*, *54*(8), 921–937. https://doi.org/10.1177/1012690218764626

Archer, T. (2014). Health benefits of physical exercise for children and adolescents. *Journal of Novel Physiotherapies*, *4*(2), Article 1000203. https://doi.org/10.4172/2165-7025.1000203

Barrett, P. (2007). Structural equation modelling: Adjudging model fit. *Personality and Individual Differences*, *42*(5), 815–824. https://doi.org/10.1016/j.paid.2006.09.018

Beets, M. W., Cardinal, B. J., & Alderman, B. L. (2010). Parental social support and the physical activity-related behaviors of youth: A review. *Health Education & Behavior*, *37*(5), 621–644. https://doi.org/10.1177/1090198110363884

Biddle, S. J., Atkin, A. J., Cavill, N., & Foster, C. (2011). Correlates of physical activity in youth: A review of quantitative systematic reviews. *International Review of Sport and Exercise Psychology*, *4*(1), 25–49. https://doi.org/10.1080/1750984X.2010.548528

Bidzan-Bluma, I., & Lipowska, M. (2018). Physical activity and cognitive functioning of children: A systematic review. *International Journal of Environmental Research and Public Health*, *15*(4), Article 800. https://doi.org/10.3390/ijerph15040800

Bittencourt, M. C., Pereira, V. L. D. d. V., & Júnior, W. P. (2015). The usability of architectural spaces: Objective and subjective qualities of built environment as multidisciplinary construction. *Procedia Manufacturing*, *3*, 6429–6436. https://doi.org/10.1016/j.promfg.2015.07.919

Bolte, G., Tamburlini, G., & Kohlhuber, M. (2010). Environmental inequalities among children in Europe - Evaluation of scientific evidence and policy implications. *European Journal of Public Health*, *20*(1), 14–20. https://doi.org/10.1093/eurpub/ckp213

Bourdieu, P. (1986). The forms of capital. In J. G. Richardson (Ed.), *Handbook of theory and research for the sociology of education* (1st ed., pp. 241–258). Greenwood Press.

Burchartz, A., Anedda, B., Auerswald, T., Giurgiu, M., Hill, H., Ketelhut, S., Kolb, S., Mall, C., Manz, K., Nigg, C. R., Reichert, M., Sprengeler, O., Wunsch, K., & Matthews, C. E. (2020). Assessing physical behavior through accelerometry – State of the science, best practices and future directions. *Psychology of Sport and Exercise*, *49*, Article 101703. https://doi.org/10.1016/j.psychsport.2020.101703

Burchartz, A., Manz, K., Anedda, B., Niessner, C., Oriwol, D., Schmidt, S. C. E., & Woll, A. (2020). Measurement of physical activity and sedentary behavior by accelerometry among a nationwide sample from the KiGGS and MoMo study: Study protocol. *JMIR Research Protocols*, *9*(7), Article e14370. https://doi.org/10.2196/14370

Burchartz, A., Oriwol, D., Kolb, S., Schmidt, S. C. E., Wunsch, K., Manz, K., Niessner, C., & Woll, A. (2021). Comparison of self-reported & device-based, measured physical activity among children in Germany. *BMC Public Health*, *21*(1), Article 1081. https://doi.org/10.1186/s12889-021-11114-y

Burdette, H. L., & Whitaker, R. C. (2005). Resurrecting free play in young children: Looking beyond fitness and fatness to attention, affiliation, and affect. *Archives of Pediatrics & Adolescent Medicine*, *159*(1), 46–50. https://doi.org/10.1001/archpedi.159.1.46

Camargo, E. M. de, da Costa, C. G., Piola, T. S., Bacil, E. D. A., López-Gil, J. F., & Campos, W. de (2023). Is greater social support from parents and friends related to higher physical activity levels among adolescents? *Children*, *10*(4), Article 701. https://doi.org/10.3390/children10040701

Colabianchi, N., Clennin, M. N., Dowda, M., McIver, K. L., Dishman, R. K., Porter, D. E., & Pate, R. R. (2019). Moderating effect of the neighbourhood physical activity environment on the relation between psychosocial factors and physical activity in children: A longitudinal study. *Journal of Epidemiology and Community Health*, *73*(7), 598–604. https://doi.org/10.1136/jech-2018-211456

Coleman, J. S. (2000). *Foundations of social theory* (3rd ed.). Belknap Press of Harvard University Press.

de la Haye, K., Robins, G., Mohr, P., & Wilson, C. (2011). How physical activity shapes, and is shaped by, adolescent friendships. *Social Science & Medicine*, *73*(5), 719–728. https://doi.org/10.1016/j.socscimed.2011.06.023

Ding, D., Sallis, J. F., Kerr, J., Lee, S [Suzanna], & Rosenberg, D. E. (2011). Neighborhood environment and physical activity among youth a review. *American Journal of Preventive Medicine*, *41*(4), 442–455. https://doi.org/10.1016/j.amepre.2011.06.036

Dobbels, L., Voets, J., Marlier, M., Waegeneer, E. de, & Willem, A. (2018). Why network structure and coordination matter: A social network analysis of sport for disadvantaged people. *International Review for the Sociology of Sport*, *53*(5), 572–593. https://doi.org/10.1177/1012690216666273

Drenowatz, C., Eisenmann, J. C., Pfeiffer, K. A., Welk, G., Heelan, K., Gentile, D., & Walsh, D. (2010). Influence of socio-economic status on habitual physical activity and sedentary behavior in 8- to 11-year old children. *BMC Public Health*, *10*, Article 214. https://doi.org/10.1186/1471-2458-10-214

Eime, R. M., Harvey, J. T., Craike, M. J., Symons, C. M., & Payne, W. R. (2013). Family support and ease of access link socio-economic status and sports club membership in adolescent girls: A mediation study. *The International Journal of Behavioral Nutrition and Physical Activity*, *10*, Article 50. https://doi.org/10.1186/1479-5868-10-50

Esser, H. (1999). *Soziologie: Allgemeine Grundlagen* (3rd ed.). Campus Verlag.

Fitzgerald, A., Fitzgerald, N., & Aherne, C. (2012). Do peers matter? A review of peer and/or friends' influence on physical activity among American adolescents.

Journal of Adolescence, *35*(4), 941–958. https://doi.org/10.1016/j.adolescence.2012.01.002

Fritsch, J., Nigg, C., Niessner, C., Schmidt, S., Woll, A., & Jekauc, D. (2023). Testing the Weiss-Harter-Model in a prospective study design: The importance of perceived social support for youth physical activity. *German Journal of Exercise and Sport Research.* Advance online publication. https://doi.org/10.1007/s12662-023-00883-w

George, A. M., Da Silva, J. A., Da Bandeira, A. S., Filho, V. C. B., Rohr, L. E., Da Lopes, A. S., & Da Silva, K. S. (2019). Association between socio-economic status and physical activity is mediated by social support in Brazilian students. *Journal of Sports Sciences*, *37*(5), 500–506. https://doi.org/10.1080/02640414.2018.1509435

Hooper, D., Coughlan, J., & Mullen, M. (2008). Structural equation modelling: Guidelines for determining model fit, *6*(1), 53–60. https://doi.org/10.21427/D7CF7R

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 1–55. https://doi.org/10.1080/10705519909540118

IBM Corp. (2021). *IBM SPSS Statistics for Windows* (Version 28.0) [Computer software]. IBM. https://www.ibm.com/de-de/spss

Janssen, I., & Leblanc, A. G. (2010). Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *The International Journal of Behavioral Nutrition and Physical Activity*, *7*, Article 40. https://doi.org/10.1186/1479-5868-7-40

Jekauc, D., Mnich, C., Niessner, C., Wunsch, K., Nigg, C. R., Krell-Roesch, J., & Woll, A. (2019). Testing the Weiss-Harter-model: Physical activity, self-esteem, enjoyment, and social support in children and adolescents. *Frontiers in Psychology*, *10*, Article 2568. https://doi.org/10.3389/fpsyg.2019.02568

Jekauc, D., Reimers, A. K., Wagner, M., & Woll, A. (2012). Prevalence and socio-demographic correlates of the compliance with the physical activity guidelines in children and adolescents in Germany. *BMC Public Health*, *12*, Article 714. https://doi.org/10.1186/1471-2458-12-714

Kline, R. B. (2016). *Principles and practice of structural equation modeling* (4th ed.). The Guilford Press.

Kok, G., Gottlieb, N. H., Commers, M., & Smerecnik, C. (2008). The ecological approach in health promotion programs: A decade later. *American Journal of Health Promotion*, *22*(6), 437–442. https://doi.org/10.4278/ajhp.22.6.437

Kurth, B.-M., Kamtsiuris, P., Hölling, H., Schlaud, M., Dölle, R., Ellert, U., Kahl, H., Knopf, H., Lange, M., Mensink, G., Neuhauser, H., Rosario, A. S., Scheidt-Nave, C., Schenk, L., Schlack, R., Stolzenberg, H., Thamm, M., Thierfelder, W., & Wolf, U. (2008). The challenge of comprehensively mapping children's health in a nation-wide health survey: Design of the German KiGGS-Study. *BMC Public Health*, *8*, Article 196. https://doi.org/10.25646/312

Lampert, T., Müters, S., Stolzenberg, H., & Kroll, L. E. (2014). Messung des sozioökonomischen Status in der KiGGS-Studie Erste Folgebefragung (KiGGS Welle 1) [Measurement of socioeconomic status in the KiGGS study: first follow-up (KiGGS Wave 1)]. *Bundesgesundheitsblatt, Gesundheitsforschung, Gesundheitsschutz*, *57*(7), 762–770. https://doi.org/10.1007/s00103-014-1974-8

Lau, E. Y., Faulkner, G., Qian, W., & Leatherdale, S. T. (2016). Associations longitudinales entre l'influence des parents et des pairs et l'activité physique durant l'adolescence: Résultats de l'étude COMPASS [Longitudinal associations of parental and peer influences with physical activity during adolescence: Findings from the COMPASS study]. *Health Promotion and Chronic Disease Prevention in Canada*, *36*(11), 235–242. https://doi.org/10.24095/hpcdp.36.11.01

Lefebvre, H. (1991). *The production of space* (1st ed.). Wiley-Blackwell.

Li, J., & Shao, W. (2022). Influence of sports activities on prosocial behavior of children and adolescents: A systematic literature review. *International Journal of Environmental Research and Public Health*, *19*(11), Article 6484. https://doi.org/10.3390/ijerph19116484

Lin, L., & Moudon, A. V. (2010). Objective versus subjective measures of the built environment, which are most effective in capturing associations with walking? *Health & Place*, *16*(2), 339–348. https://doi.org/10.1016/j.healthplace.2009.11.002

Loh, V. H. Y., Veitch, J., Salmon, J., Cerin, E., Thornton, L., Mavoa, S., Villanueva, K., & Timperio, A. (2019). Built environment and physical activity among adolescents: The moderating effects of neighborhood safety and social

support. *The International Journal of Behavioral Nutrition and Physical Activity*, *16*(1), Article 132. https://doi.org/10.1186/s12966-019-0898-y

Löw, M. (2016). *The sociology of space: Materiality, social structures, and action* (1st ed.). Palgrave Macmillan. https://doi.org/10.1057/978-1-349-69568-3

Mendonça, G., Cheng, L. A., Mélo, E. N., & de Farias Júnior, J. C. (2014). Physical activity and social support in adolescents: A systematic review. *Health Education Research*, *29*(5), 822–839. https://doi.org/10.1093/her/cyu017

Molina-García, J., Queralt, A., Adams, M. A., Conway, T. L., & Sallis, J. F. (2017). Neighborhood built environment and socio-economic status in relation to multiple health outcomes in adolescents. *Preventive Medicine*, *105*, 88–94. https://doi.org/10.1016/j.ypmed.2017.08.026

Nigg, C. R., Fuchs, R., Gerber, M., Jekauc, D., Koch, T., Krell-Roesch, J., Lippke, S., Mnich, C., Novak, B., Ju, Q., Sattler, M. C., Schmidt, S. C. E., van Poppel, M., Reimers, A. K., Wagner, P., Woods, C., & Woll, A. (2020). Assessing physical activity through questionnaires – A consensus of best practices and future directions. *Psychology of Sport and Exercise*, *50*, Article 101715. https://doi.org/10.1016/j.psychsport.2020.101715

Pate, R. R., Dowda, M., Dishman, R. K., Colabianchi, N., Saunders, R. P., & McIver, K. L. (2019). Change in children's physical activity: Predictors in the transition from elementary to middle school. *American Journal of Preventive Medicine*, *56*(3), e65-e73. https://doi.org/10.1016/j.amepre.2018.10.012

Prochnow, T., Curran, L. S., Amo, C., & Patterson, M. S. (2023). Bridging the built and social environments: A systematic review of studies investigating influences on physical activity. *Journal of Physical Activity & Health*, *20*(5), 438–459. https://doi.org/10.1123/jpah.2022-0403

Prochnow, T., Patterson, M. S., Sharkey, J., & Umstattd Meyer, M. R. (2020). Health coalition collaboration network, perceived satisfaction and success. *Journal of Health Organization and Management*, *34*(8), 885–897. https://doi.org/10.1108/JHOM-04-2020-0120

Putnam, R. D. (2001). *Bowling alone: The collapse and revival of American community* (1st ed.). Simon & Schuster.

Reimers, A. K., Jekauc, D., Mess, F., Mewes, N., & Woll, A. (2012). Validity and reliability of a self-report instrument to assess social support and physical

environmental correlates of physical activity in adolescents. *BMC Public Health*, *12*(1), Article 705. https://doi.org/10.1186/1471-2458-12-705

Reimers, A. K., Schmidt, S. C. E., Demetriou, Y., Marzi, I., & Woll, A. (2019). Parental and peer support and modelling in relation to domain-specific physical activity participation in boys and girls from Germany. *PloS One*, *14*(10), Article e0223928. https://doi.org/10.1371/journal.pone.0223928

Rhodes, R. E., Perdew, M., & Malli, S. (2020). Correlates of parental support of child and youth physical activity: A systematic review. *International Journal of Behavioral Medicine*, *27*(6), 636–646. https://doi.org/10.1007/s12529-020-09909-1

Rittsteiger, L., Hinz, T., Oriwol, D., Wäsche, H., Santos-Hövener, C., & Woll, A. (2021). Sports participation of children and adolescents in Germany: Disentangling the influence of parental socioeconomic status. *BMC Public Health*, *21*(1), Article 1446. https://doi.org/10.1186/s12889-021-11284-9

Ryan, L., Sales, R., Tilki, M., & Siara, B. (2008). Social networks, social support and social capital: The experiences of recent polish migrants in London. *Sociology*, *42*(4), 672–690. https://doi.org/10.1177/0038038508091622

Sallis, J. F., Prochaska, J. J., & Taylor, W. C. (2000). A review of correlates of physical activity of children and adolescents. *Medicine and Science in Sports and Exercise*, *32*(5), 963–975. https://doi.org/10.1097/00005768-200005000-00014

Sallis, J. F., Taylor, W. C., Dowda, M., Freedson, P. S., & Pate, R. R. (2002). Correlates of vigorous physical activity for children in grades 1 through 12: Comparing parent-reported and objectively measured physical activity. *Pediatric Exercise Science*, *14*(1), 30–44. https://doi.org/10.1123/pes.14.1.30

Santiago-Torres, M., Cui, Y., Adams, A. K., Allen, D. B., Carrel, A. L., Guo, J. Y., LaRowe, T. L., & Schoeller, D. A. (2016). Structural equation modeling of the associations between the home environment and obesity-related cardiovascular fitness and insulin resistance among Hispanic children. *Appetite*, *101*, 23–30. https://doi.org/10.1016/j.appet.2016.02.003

Schmidt, S. C. E., Anedda, B., Burchartz, A., Eichsteller, A., Kolb, S., Nigg, C., Niessner, C., Oriwol, D., Worth, A., & Woll, A. (2020). Physical activity and screen time of children and adolescents before and during the COVID-19 lockdown in

Germany: A natural experiment. *Scientific Reports*, *10*(1), Article 21780. https://doi.org/10.1038/s41598-020-78438-4

Schmidt, S. C. E., Schneider, J., Reimers, A. K., Niessner, C., & Woll, A. (2019). Exploratory determined correlates of physical activity in children and adolescents: The MoMo study. *International Journal of Environmental Research and Public Health*, *16*(3), Article 415. https://doi.org/10.3390/ijerph16030415

Schoeppe, S., Duncan, M. J., Badland, H., Oliver, M., & Curtis, C. (2013). Associations of children's independent mobility and active travel with physical activity, sedentary behaviour and weight status: A systematic review. *Journal of Science and Medicine in Sport*, *16*(4), 312–319. https://doi.org/10.1016/j.jsams.2012.11.001

Schulz, B., Horr, A., & Hoenig, K. (2017). *The position generator in the NEPS* (NEPS Survey Paper No. 23). Leibniz Institute for Educational Trajectories, National Educational Panel Study. https://doi.org/10.5157/NEPS:SP23:1.0

Shaw, B., Bicket, M., Elliot, B., Fagan-Watson, B., Mocca, E., & Hillman, M. (2015). *Children's independent mobility. An international comparison and recommendations for action.* London. Policy Studies Institute. http://www.psi.org.uk/children_mobility

Slootmaker, S. M., Schuit, A. J., Chinapaw, M. J., Seidell, J. C., & van Mechelen, W. (2009). Disagreement in physical activity assessed by accelerometer and self-report in subgroups of age, gender, education and weight status. *The International Journal of Behavioral Nutrition and Physical Activity*, *6*, Article 17. https://doi.org/10.1186/1479-5868-6-17

Sterdt, E., Liersch, S., & Walter, U. (2014). Correlates of physical activity of children and adolescents: A systematic review of reviews. *Health Education Journal*, *73*(1), 72–89. https://doi.org/10.1177/0017896912469578

Tandon, P. S., Kroshus, E., Olsen, K., Garrett, K., Qu, P., & McCleery, J. (2021). Socioeconomic inequities in youth participation in physical activity and sports. *International Journal of Environmental Research and Public Health*, *18*(13), Article 6946. https://doi.org/10.3390/ijerph18136946

Twisk, J. W. R., Kemper, H. C. G., & van Mechelen, W. (2002). Prediction of cardiovascular disease risk factors later in life by physical activity and physical fitness in youth: General comments and conclusions. *International Journal of Sports Medicine*, *23*(Suppl. 1), 44-49. https://doi.org/10.1055/s-2002-28461

van Leeuwen, L., Annink, A., Visser, K., & Jambroes, M. (2022). Facilitating children's club-organized sports participation: Person–environment misfits experienced by parents from low-income families. *Children*, *9*(11), Article 1746. https://doi.org/10.3390/children9111746

Wäsche, H. (2022). Auf die Beziehungen kommt es an! Die Analyse sozialer Netzwerke in der Sportwissenschaft. *Sport Und Gesellschaft*, *19*(2), 131–162. https://doi.org/10.1515/sug-2022-0015

Wäsche, H., Dickson, G., Woll, A., & Brandes, U. (2017). Social network analysis in sport research: An emerging paradigm. *European Journal for Sport and Society*, *14*(2), 138–165. https://doi.org/10.1080/16138171.2017.1318198

Wäsche, H., Wolbring, L., & Woll, A. (2021). Physical activity promotion in an urban district: Analyzing the mechanisms of interorganizational cooperation. *PloS One*, *16*(11), Article e0260053. https://doi.org/10.1371/journal.pone.0260053

Wolbring, L., Schmidt, S. C. E., Niessner, C., Woll, A., & Wäsche, H. (2022). Community networks of sport and physical activity promotion: An analysis of structural properties and conditions of cooperation. *BMC Public Health*, *22*(1), Article 1966. https://doi.org/10.1186/s12889-022-14383-3

Woll, A., Albrecht, C., & Worth, A. (2017). Motorik-Module (MoMo) – the KiGGS wave 2 module to survey motor performance and physical activity. *Journal of Health Monitoring*, *2*(Suppl. 3), 63–70. https://doi.org/10.17886/RKI-GBE-2017-110

World Health Organization. (2010). *Global recommendations on physical activity for health*. World Health Organization. https://www.who.int/publications-detail-redirect/9789241599979

Young, D., Saksvig, B. I., Wu, T. T., Zook, K., Li, X., Champaloux, S., Grieser, M., Lee, S [Sunmin], & Treuth, M. S. (2014). Multilevel correlates of physical activity for early, mid, and late adolescent girls. *Journal of Physical Activity & Health*, *11*(5), 950–960. https://doi.org/10.1123/jpah.2012-0192

Chapter 6: General discussion

The aim of this doctoral thesis was to analyze social and environmental structures of sport and physical activity. The findings are to be used to develop systematic and sustainable strategies for sport and physical activity promotion.

With the infrastructure, the relationship structure, and the structures of social inequality, this work highlights various dimensions of societal structures (Esser, 1999). We examined the structural conditions of physical activity promotion at different levels: In our first paper (Wolbring et al., 2021), we focused on change agents of physical activity promotion and their involvement in the dissemination of physical activity recommendations at the national level. The analyzed networks of sport and physical activity providers in our second and third paper were located on the community level (Wäsche et al., 2021; Wolbring et al., 2022). In our fourth paper (Wolbring et al., submitted), we examined the structural determinants of physical activity behavior at the individual level. Based on this, generic approaches for a population-wide physical activity promotion can be derived, as well as environmentally based approaches and individual approaches.

We were able to identify conditions at the national, community, and individual levels under which a structural and environmental promotion of physical activity can take place. The central results of this work are presented below:

1. To translate national physical activity recommendations into practice involving change agents, the following needs have to be met:
    a. Strengthening political will and intersectoral cooperation of relevant actors.
    b. Availability of public spaces for physical activity and physical activity promotion
    c. Health education and change of awareness regarding the importance of physical activity in the population as a whole and in individual areas of society
    d. Integration of physical activity promotion in the vocational training of educational staff

   e. Financial incentives for individuals and relevant change agents to become involved in PA promotion
   f. Development of programs and structures that promote physical activity in schools, kindergartens, workplaces, clubs, communities
   g. Provision of resources (financial, personnel, spatial) and practical instruments that support change agents in a scientifically based and efficient implementation of physical activity recommendations
   h. Bridging the theory-practice gap through transdisciplinary approaches
   i. Knowledge of physical activity recommendations in relevant settings
2. Community networks of sport and physical activity promotion are rather fragmented. Cooperation took place in triangular structures and revolved around a few central actors. Organizations from different sectors cooperated more frequently with each other than organizations from the same sector. To strengthen the networks' capacity regarding sport and physical activity promotion, common goals have to be defined, isolated actors should be integrated, and networks have to be managed appropriately. Based on the structure and conditions of cooperation identified, a hybrid of a lead organization- or leading group-governed network, where cooperation and information dissemination are centrally coordinated, and a participant-governed network, where the participants themselves manage the cooperation in smaller subgroups, might be the most effective governance form for this type of networks.
3. When considering socio-structural determinants, social support has the strongest influence on physical activity behavior in children and adolescents. The direct influence of socioeconomic status is rather low but it has an indirect effect via social support and, for adolescents, also via the perceived physical environment. Interventions aimed at increasing physical activity levels in children and adolescent should therefore focus on components of social support from family and peers. To create equal health opportunities, appropriate policies and services at the level of the physical environment and social integration are needed to enable socially disadvantaged children and adolescents to participate in sport and physical activity.

The central results of our work show that at all levels considered, the relationship structure is of major importance. At both the national and community levels, intersectoral

networks of relevant actors, including those not directly related to the sport and health sectors, appear to be beneficial. In this way, resources and knowledge can be shared and holistic solutions can be developed, incorporating different perspectives (Bevc et al., 2015; Lasker & Weiss, 2003a; Provan et al., 2005; Varda et al., 2008, 2008). It is crucial that common goals are pursued in such networks and that the networks are coordinated efficiently (Provan & Kenis, 2007; Provan et al., 2003; Varda et al., 2012). At the individual level, relationship structures are also central to the physical activity behavior of children and adolescents. Here, social support, evolving from networks of close social relations and also referred to as "bonding" social capital (Putnam, 2001), influences not only the amount of physical activity, but also perceptions regarding a physical environment conducive to sport and physical activity.

The structures of social inequality should be given special consideration in the context of physical activity promotion, so that socially disadvantaged population groups benefit from established measures to the same extent as population groups with higher socioeconomic status. At the national level, change agents with decision making power can change the legal framework and initiate policies to reduce social inequities in health and physical activity (Dahlgren & Whitehead, 2006). Change agents at the community and individual levels can facilitate access to target groups that are difficult to reach in physical activity promotion, such as socially disadvantaged population groups, as they have knowledge about their cultural peculiarities and individual needs (Bartholomew Eldredge et al., 2016; Reifegerste, 2021; Valente & Pumpuang, 2007). Especially, community networks of change agents as part of local sports, youth, health, and social organizations can be a good starting point for tackling structures of social inequality. They are in direct contact to the relevant population groups and can jointly develop suitable offers (Dobbels et al., 2018; Wäsche et al., 2021; Wolbring et al., 2022). On an individual level, structures of social inequality played an indirect role regarding the physical activity behavior of young age groups. Therefore, it is important to create low-threshold services for this target group that are adapted to their needs in order to contribute to equal health opportunities (Tandon et al., 2021). However, previous research has shown that high levels of social capital can even compensate for socioeconomic disadvantage (Coleman, 2000; Putnam, 2001) and detrimental physical environmental factors (Alfonzo, 2005) in the context of health and physical activity.

This once again underscores the relevance of relationship structures in the context of physical activity promotion.

Our results further show that the infrastructure, as the material basis of society, is also of central importance in the context of physical activity promotion. At the community level, the implementation of national physical activity recommendations requires appropriate spaces and opportunities (Bauman et al., 2012; Tcymbal et al., 2020; Wolbring et al., 2021). In this regard, public administrations, e.g., urban planning departments, play a particularly important role. In addition, local interorganizational networks, which serve as a background organization to community sport and physical activity, can alleviate access to physical activity spaces and sports facilities. On an individual level, we were able to show that the perceived physical environment has a positive influence on physical activity, especially among adolescents. Although previous research has shown that environmental measures, such as designing living environments conducive to physical activity, are particularly effective in reaching socially disadvantaged population groups (Kuntz et al., 2018; Rütten, 2017; Rütten & Pfeifer, 2016), our results indicate that perceptions of the environment are also shaped by social structures. The higher the socioeconomic status and the social support from friends and family, the more physical activity-friendly the environment is perceived. Thus, in line with previous studies (Colabianchi et al., 2019; Kaczynski & Glover, 2012; Loh et al., 2019) and with Löw's (2016) and Lefebvre's (1991) concept of space, our findings show that the perception of the environment is not solely shaped by objective characteristics but is also socially determined. This suggests that policies and interventions addressing social structures are particularly effective to establish equal access to spaces and opportunities for sport and physical activity.

Based on a pragmatic maxim, a major strength of this work lies in the diversity of theoretical and methodological approaches used to answer the research questions. By combining social ecological, network theoretical and setting-based approaches, the complexity of the influences on physical activity behavior from a structural perspective was accounted for. To develop solutions oriented to the everyday lives of the people concerned, we merged the subjective views of change agents with objectively measured data while adhering to the principles of neutrality and freedom from value judgement. The choice of the methodological approaches was determined by the respective research questions of the individual parts of this work. Thus, qualitative as well as

network-analytical and quantitative methods were used, which allowed to shed light on different facets of the conditions of a structural and environmental promotion of physical activity. In this way, we were also able to identify some cross-connections between the considered structures of physical activity promotion at different levels. The qualitative approach to analyzing the change agents' needs regarding physical activity promotion allowed us to gain deep insights into the facilitators and barriers of their behavior. The application of network analytic methods in sport science is a relatively new perspective (Wäsche et al., 2017). By looking at relational structures, we were able to demonstrate a novel approach to analyzing and creating physical activity promoting structures that can contribute to solving this overall societal challenge in an innovative way. Another strength of this dissertation is the use of device-based measurement methods to capture physical activity in a large sample. The results obtained provide a sound and reliable basis for developing effective interventions to promote physical activity.

However, some limitations need to be discussed. The explorative approach of the first study of this doctoral thesis allows insights into the needs of change agents of physical activity promotion but cannot claim to be representative. We have tried to cover as many sectors of society and administrative levels as possible but we cannot rule out the possibility that there are further needs for the implementation of national physical activity recommendations that we have not been able to uncover. Moreover, all data collected in this paper are cross-sectional and do not allow for longitudinal analyses and causal statements but reflect the state at the time of data collection. Through our theory-driven approach, however, we were able to derive explanations for the identified relationships. Particularly with regard to the networks considered, these represent only a snapshot of the relationship structures existing at the time of the survey. However, studies like these are still the most common approach in network research as they provide insights into the phenomena and structures of an emerging research field. Finally, much of the data collected in this work is based on self-report measures which may inherently be subject to some degree of recall bias and social desirability.

The results of this work shed light on various conditions of a structural and environmental promotion of physical activity and provide implications for future research and practice.

In order to disseminate national physical activity recommendations, the use of change agents from different sectors of society seems essential. In an exploratory approach, we identified various cross-sectoral needs and barriers to the implementation of physical activity recommendations. In the context of physical activity promotion, a theory-practice gap is often criticized which causes measures and recommendations not to be adapted to specific settings and their particularities (Ballew et al., 2010; Brownson et al., 2007; Davis et al., 2017). Consequently, setting-specific needs should be collected and included in a representative way in future research. It is particularly important to choose transdisciplinary approaches of research and practice (Glasgow & Emmons, 2007) so that measures are adapted to the needs of local contexts and also find acceptance with change agents.

Intersectoral cooperation is often considered essential in the context of sport and physical activity promotion (Bevc et al., 2015; Lasker & Weiss, 2003b; Mays & Scutchfield, 2010; Varda et al., 2008). The insights gained in this work should help communities and their organizations to establish and develop networks in a targeted manner and to see them as an integrative part of community sports development. At a higher level, the development of cooperative structures should be enabled through political support and funding in order to facilitate population health benefits (McCartney et al., 2019). To consolidate findings on community cooperation networks of sport and physical activity providers, further studies such as those presented in this thesis are needed. In this way, overarching insights into the structures and mechanisms can be gained that go beyond individual case studies, and recommendations for expanding the networks can be derived. Barriers and obstacles to cooperation should also be considered in order to derive measures to overcome them. So far, there are only few long-term studies on the effectiveness of cooperative activities and networks in the context of sport and physical activity promotion. Future research should therefore also focus on network effects in order to determine the extent to which the networks themselves and the implemented network development measures can have a positive influence on the physical activity behavior of the corresponding target groups.

In this work, the primary focus was on networks of sport and physical activity promotion at the community level. Future research should also focus on state and national networks that can influence decisions and structures at a higher level. The actors of these networks are possibly not in direct contact with the target group but may be able to

exercise more decision-making power. Therefore, they can initiate laws and policies and provide financial resources that enable physical activity and sport at lower levels (Giles-Corti et al., 2015; Piercy et al., 2015; van Rinsum et al., 2017). In this context, the cross-connections and interactions between the networks at different levels (community, state, national) should also be considered to encourage cooperative policy formulation and implementation.

In order to address socially disadvantaged children and adolescents in particular, stakeholders in research and practice should work together to develop and evaluate concrete interventions and measures that strengthen social support with regard to physical activity and sport. Here, kindergartens and schools can play an important role in working with parents and children by providing appropriate services or integrating them into the curriculum (Camargo et al., 2023; Fitzgerald et al., 2012). Furthermore, app-based interventions at the family level (Wunsch et al., 2020) could be a promising approach to foster social support for physical activity.

In summary, this work makes an important contribution to the investigation of the conditions under which a structural and environmental promotion of physical activity can take place. We examined the relationship structure, the structures of social inequality, and the infrastructure on an individual, community, and national level and derived measures and recommendations to increase physical activity behavior. In a multi-theoretical and multi-method approach, we were able to shed light on and unite different facets of this research field. We developed recommendations for an evidence-based strategy for the dissemination of national physical activity recommendations involving various change agents of physical activity promotion (Chapter 2). On a community level, we revealed cooperation structures of sport and physical activity providers and enabled an understanding of how cooperation of community change agents works in the context of sport and physical activity promotion. Thereby, we were able to derive recommendations for the efficient governance and management of such networks (Chapter 3 and 4). Finally, we could illustrate the importance of close social relationships with family and friends as well as social capital as a source of social support for the physical activity behavior of young age groups. To contribute to equal health opportunities, we concluded that appropriate measures at the level of the physical environment and social integration are needed that enable socially disadvantaged children and adolescents to participate in sport and physical activity (Chapter 5).

In conclusion, we are convinced that building physical activity-friendly environments, systems, and societies is a central pillar to address major public health challenges such as physical inactivity. The findings and recommendations gained in this dissertation are equally relevant for political decision-makers and practitioners. From a scientific viewpoint, future research can build on the insights generated in this work to further leverage the potential of interventions aimed at changing environmental and structural conditions.

References

Alfonzo, M. A. (2005). To walk or not to walk? The hierarchy of walking needs. *Environment and Behavior*, *37*(6), 808–836. https://doi.org/10.1177/0013916504274016

Ballew, P., Brownson, R. C., Haire-Joshu, D., Heath, G. W., & Kreuter, M. W. (2010). Dissemination of effective physical activity interventions: Are we applying the evidence? *Health Education Research*, *25*(2), 185–198. https://doi.org/10.1093/her/cyq003

Bartholomew Eldredge, L. K., Markham, C. M., Ruiter, R. A. C., Fernández, M. E., Kok, G., & Parcel, G. S. (2016). *Planning health promotion programs: An intervention mapping approach* (4th ed.). Jossey-Bass.

Bauman, A. E., Reis, R. S., Sallis, J. F., Wells, J. C., Loos, R. J. F., & Martin, B. W. (2012). Correlates of physical activity: Why are some people physically active and others not? *The Lancet*, *380*(9838), 258–271. https://doi.org/10.1016/S0140-6736(12)60735-1

Bevc, C. A., Retrum, J. H., & Varda, D. M. (2015). New perspectives on the "silo effect": Initial comparisons of network structures across public health collaboratives. *American Journal of Public Health*, *105*(Suppl. 2), 230-235. https://doi.org/10.2105/AJPH.2014.302256

Brownson, R. C., Ballew, P., Dieffenderfer, B., Haire-Joshu, D., Heath, G. W., Kreuter, M. W., & Myers, B. A. (2007). Evidence-based interventions to promote physical activity: What contributes to dissemination by state health departments. *American Journal of Preventive Medicine*, *33*(1, Suppl.), S66-S73. https://doi.org/10.1016/j.amepre.2007.03.011

Camargo, E. M. de, da Costa, C. G., Piola, T. S., Bacil, E. D. A., López-Gil, J. F., & Campos, W. de (2023). Is greater social support from parents and friends

related to higher physical activity levels among adolescents? *Children*, *10*(4), Article 701. https://doi.org/10.3390/children10040701

Colabianchi, N., Clennin, M. N., Dowda, M., McIver, K. L., Dishman, R. K., Porter, D. E., & Pate, R. R. (2019). Moderating effect of the neighbourhood physical activity environment on the relation between psychosocial factors and physical activity in children: A longitudinal study. *Journal of Epidemiology and Community Health*, *73*(7), 598–604. https://doi.org/10.1136/jech-2018-211456

Coleman, J. S. (2000). *Foundations of social theory* (3rd ed.). Belknap Press of Harvard University Press.

Dahlgren, G., & Whitehead, M. (2006). *European strategies for tackling social inequities in health: Levelling up Part 2*. World Health Organization Regional Office for Europe.

Davis, S. M., Cruz, T. H., & Kozoll, R. L. (2017). Research to practice: Implementing physical activity recommendations. *American Journal of Preventive Medicine*, *52*(3.3, Suppl.), S300-S303. https://doi.org/10.1016/j.amepre.2016.09.028

Dobbels, L., Voets, J., Marlier, M., Waegeneer, E. de, & Willem, A. (2018). Why network structure and coordination matter: A social network analysis of sport for disadvantaged people. *International Review for the Sociology of Sport*, *53*(5), 572–593. https://doi.org/10.1177/1012690216666273

Esser, H. (1999). *Soziologie: Allgemeine Grundlagen* (3rd ed.). Campus Verlag.

Fitzgerald, A., Fitzgerald, N., & Aherne, C. (2012). Do peers matter? A review of peer and/or friends' influence on physical activity among American adolescents. *Journal of Adolescence*, *35*(4), 941–958. https://doi.org/10.1016/j.adolescence.2012.01.002

Giles-Corti, B., Sallis, J. F., Sugiyama, T., Frank, L. D., Lowe, M., & Owen, N. (2015). Translating active living research into policy and practice: One important pathway to chronic disease prevention. *Journal of Public Health Policy*, *36*(2), 231–243. https://doi.org/10.1057/jphp.2014.53

Glasgow, R. E., & Emmons, K. M. (2007). How can we increase translation of research into practice? Types of evidence needed. *Annual Review of Public Health*, *28*, 413–433. https://doi.org/10.1146/annurev.publhealth.28.021406.144145

Kaczynski, A. T., & Glover, T. D. (2012). Talking the talk, walking the walk: Examining the effect of neighbourhood walkability and social connectedness on

physical activity. *Journal of Public Health*, *34*(3), 382–389. https://doi.org/10.1093/pubmed/fds011

Kuntz, B., Waldhauer, J., Zeiher, J., Finger, J. D., & Lampert, T. (2018). Soziale Unterschiede im Gesundheitsverhalten von Kindern und Jugendlichen in Deutschland – Querschnittergebnisse aus KiGGS Welle 2. *Journal of Health Monitoring*, *3*(2), 45–63. https://doi.org/10.17886/RKI-GBE-2018-067

Lasker, R. D., & Weiss, E. S. (2003a). Broadening participation in community problem solving: A multidisciplinary model to support collaborative practice and research. *Journal of Urban Health*, *80*(1), 14-47. https://doi.org/10.1093/jurban/jtg014

Lasker, R. D., & Weiss, E. S. (2003b). Creating partnership synergy: The critical role of community stakeholders. *Journal of Health and Human Services Administration*, *26*(1), 119–139. https://www.jstor.org/stable/41288031

Lefebvre, H. (1991). *The production of space* (1st ed.). Wiley-Blackwell.

Loh, V. H. Y., Veitch, J., Salmon, J., Cerin, E., Thornton, L., Mavoa, S., Villanueva, K., & Timperio, A. (2019). Built environment and physical activity among adolescents: The moderating effects of neighborhood safety and social support. *The International Journal of Behavioral Nutrition and Physical Activity*, *16*(1), Article 132. https://doi.org/10.1186/s12966-019-0898-y

Löw, M. (2016). *The sociology of space: Materiality, social structures, and action* (1st ed.). Palgrave Macmillan. https://doi.org/10.1057/978-1-349-69568-3

Mays, G. P., & Scutchfield, F. D. (2010). Improving public health system performance through multiorganizational partnerships. *Preventing Chronic Disease*, *7*(6), Article 116.

McCartney, G., Hearty, W., Arnot, J., Popham, F., Cumbers, A., & McMaster, R. (2019). Impact of political economy on population health: A systematic review of reviews. *American Journal of Public Health*, *109*(6), e1-e12. https://doi.org/10.2105/AJPH.2019.305001

Piercy, K. L., Dorn, J. M., Fulton, J. E., Janz, K. F., Lee, S. M., McKinnon, R. A., Pate, R. R., Pfeiffer, K. A., Young, D. R., Troiano, R. P., & Lavizzo-Mourey, R. (2015). Opportunities for public health to increase physical activity among youths. *American Journal of Public Health*, *105*(3), 421–426. https://doi.org/10.2105/AJPH.2014.302325

Provan, K. G., & Kenis, P. (2007). Modes of network governance: Structure, management, and effectiveness. *Journal of Public Administration Research and Theory*, *18*(2), 229–252. https://doi.org/10.1093/jopart/mum015

Provan, K. G., Nakama, L., Veazie, M. A., Teufel-Shone, N. I., & Huddleston, C. (2003). Building community capacity around chronic disease services through a collaborative interorganizational network. *Health Education & Behavior*, *30*(6), 646–662. https://doi.org/10.1177/1090198103255366

Provan, K. G., Veazie, M. A., Staten, L. K., & Teufel-Shone, N. I. (2005). The use of network analysis to strengthen community partnerships. *Public Administration Review*, *65*(5), 603–613. https://doi.org/10.1111/j.1540-6210.2005.00487.x

Putnam, R. D. (2001). *Bowling alone: The collapse and revival of American community* (1st ed.). Simon & Schuster.

Reifegerste, D. (2021). Gesundheitskommunikation in der Prävention und Gesundheitsförderung für schwer erreichbare Zielgruppen. In M. Tiemann & M. Mohokum (Eds.), *Prävention und Gesundheitsförderung* (1st ed., pp. 285–293). Springer. https://doi.org/10.1007/978-3-662-62426-5_16

Rütten, A. (2017). Sportwissenschaft, Bewegungsförderung und Public Health. *German Journal of Exercise and Sport Research*, *47*(1), 72–81. https://doi.org/10.1007/s12662-016-0434-z

Rütten, A., & Pfeifer, K. (Eds.). (2016). *Nationale Empfehlungen für Bewegung und Bewegungsförderung*. FAU Erlangen-Nürnberg.

Tandon, P. S., Kroshus, E., Olsen, K., Garrett, K., Qu, P., & McCleery, J. (2021). Socioeconomic inequities in youth participation in physical activity and sports. *International Journal of Environmental Research and Public Health*, *18*(13), Article 6946. https://doi.org/10.3390/ijerph18136946

Tcymbal, A., Demetriou, Y., Kelso, A., Wolbring, L., Wunsch, K., Wäsche, H., Woll, A., & Reimers, A. K. (2020). Effects of the built environment on physical activity: A systematic review of longitudinal studies taking sex/gender into account. *Environmental Health and Preventive Medicine*, *25*(1), Article 75. https://doi.org/10.1186/s12199-020-00915-z

Valente, T. W., & Pumpuang, P. (2007). Identifying opinion leaders to promote behavior change. *Health Education & Behavior*, *34*(6), 881–896. https://doi.org/10.1177/1090198106297855

van Rinsum, C. E., Gerards, S., Rutten, G. M., van de Goor, I., & Kremers, S. (2017). Health brokers: How can they help deal with the wickedness of public health problems? *BioMed Research International*, *2017*, Article 1979153. https://doi.org/10.1155/2017/1979153

Varda, D. M., Chandra, A., Stern, S. A., & Lurie, N. (2008). Core dimensions of connectivity in public health collaboratives. *Journal of Public Health Management and Practice*, *14*(5), E1-7. https://doi.org/10.1097/01.PHH.0000333889.60517.46

Varda, D. M., Shoup, J. A., & Miller, S. (2012). A systematic review of collaboration and network research in the public affairs literature: Implications for public health practice and research. *American Journal of Public Health*, *102*(3), 564–571. https://doi.org/10.2105/AJPH.2011.300286

Wäsche, H., Dickson, G., Woll, A., & Brandes, U. (2017). Social network analysis in sport research: An emerging paradigm. *European Journal for Sport and Society*, *14*(2), 138–165. https://doi.org/10.1080/16138171.2017.1318198

Wäsche, H., Wolbring, L., & Woll, A. (2021). Physical activity promotion in an urban district: Analyzing the mechanisms of interorganizational cooperation. *PloS One*, *16*(11), Article e0260053. https://doi.org/10.1371/journal.pone.0260053

Wolbring, L., Jekauc, D., Hinz, T., Burchartz, A., Kolb, S., Schmidt, S. C. E., Woll, A., & Wäsche, H. (submitted). Socio-structural determinants of physical activity behavior in children and adolescents: The importance of social support. *Social Science & Medicine*.

Wolbring, L., Reimers, A. K., Niessner, C., Demetriou, Y., Schmidt, S. C. E., Woll, A., & Wäsche, H. (2021). How to disseminate national recommendations for physical activity: A qualitative analysis of critical change agents in Germany. *Health Research Policy and Systems*, *19*(1), Article 78. https://doi.org/10.1186/s12961-021-00729-7

Wolbring, L., Schmidt, S. C. E., Niessner, C., Woll, A., & Wäsche, H. (2022). Community networks of sport and physical activity promotion: An analysis of structural properties and conditions of cooperation. *BMC Public Health*, *22*(1), Article 1966. https://doi.org/10.1186/s12889-022-14383-3

Wunsch, K., Eckert, T., Fiedler, J., Cleven, L., Niermann, C., Reiterer, H., Renner, B., & Woll, A. (2020). Effects of a collective family-based mobile health intervention called "SMARTFAMILY" on promoting physical activity and healthy eating:

Protocol for a randomized controlled trial. *JMIR Research Protocols*, *9*(11), Article e20534. https://doi.org/10.2196/20534