

# Systems thinking and complexity science in sport policy

## A scoping review of the research

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### Abstract

Systems thinking and complexity science have expanded in recent years within sport policy research, particularly in the examination of physical activity policies. This trend is based on a growing recognition of the complex nature of sport and sport policies, which calls for new theories and methods of analysis. To provide an overall picture of the current state of the research, we conducted a scoping review guided by the following research questions: What type of research has been conducted using systems approach in sport policy? What are the primary benefits and challenges regarding the use of systems approach reported in the study findings? Data were collected from the EBSCOhost, PubMed, and Scopus databases and reported in accordance with PRISMA-ScR. Following the search, 19 articles were included. We found that the use of systems approaches in sport policy is rare, although it represents an emerging field of research. The findings confirmed that physical activity promotion emerged as the main focus area, whereas studies on organised sport were scarce. The results underscore the potential of incorporating systems approach into future sport policy research. However, there is a need to carefully evaluate both the opportunities and potential pitfalls associated with this approach. By doing so, researchers may contribute to a more comprehensive understanding of the sport policy system.

**Keywords:** systems approach, systems thinking, complexity science, sport policy, physical activity policy, complex systems, public policy

## Introduction

The complex nature of sport is widely recognised in academic research overall (McLean et al. 2025) as well as in sport policy research (Hoekman and Scheerder 2021). Sam (2009) points out several characteristics of complexity that can be applied to sports policy such as difficulties in issue definition, uncertainties regarding causal chains and working mechanisms, and a propensity for remedies to result in new or unintended problems or exacerbate existing challenges. Based on this, new approaches in which, for example, power relations, resource dependencies, historical roots, beliefs, and structural aspects are under consideration at the same time, are needed (cf. Fahlén et al. 2015).

Systems approach, including both systems thinking and complexity science methods, is a potential scientific practice that can be utilised to construct more comprehensive and context-specific sport policy research (see Rutter et al. 2019, McLean et al. 2021). Sport policy researchers have traditionally investigated sport-related issues by utilising analytical frameworks from other disciplines, primarily focusing on macro-level policy processes (Houlihan 2005, Jayawardhana and Piggin 2021). However, these theories and frameworks can be criticised for offering a limited view, thus hindering the overall understanding of sport policy. Jayawardhana and Piggin (2021) highlighted the necessity of developing new theories and methodologies for studying sport policy because existing frameworks may not adequately capture specific areas of sport policy processes.

Systems thinking and complexity science are holistically oriented research traditions that share mutual elements, although they cannot be viewed as a unified theoretical framework (Rusoja et al. 2018). These mutually connected elements include a holistic way of thinking and recognising system dynamics, interrelationships, and context-dependency (Rusoja et al. 2018). The aim is to understand the complexity of the system and the pursuit of understanding ‘interrelationships rather than things’, and ‘patterns of change rather than static “snapshots”’, which are essential to systems approaches (Senge 1990, p. 23, Ross and Wade 2015).

### *Exploring systems approach in sport policy research*

Although there is no universally agreed definition of the term *system*, it typically suggests a sense of relatedness, togetherness, and integration (Morçöl 2012). In basic terms, a system refers to a group of related el-

ements. Systems thinking examines structures and boundaries of a system and the interactions of agents, usually individuals, within the system (McGill et al. 2021). This involves different theories, methods, tools and concepts that help to understand and articulate different chains of events in policy-making (Peters 2014). Complexity science primarily focuses on analysing changes in dynamic systems (McGill et al. 2021). Policy-making systems can be viewed as complex systems that contain multiple interactions, feedback loops, nonlinear dynamics, information flows, and sometimes unexpected results from policy actions (Cairney 2012). Combining systems thinking and complexity science can enhance the explanatory power of research on complex phenomena (see Gates 2016, McGill et al. 2021, Jalonon 2024).

Taking into account the many factors influencing policy-making in sport, sport policy can be characterised as a complex system for several reasons. First, the functioning of complex systems cannot be explained by breaking them down into parts, as spontaneous self-organisation produces emergent properties not found in individual components but as a result of several factors (Eppel and Rhodes 2018). Applied in sport policy, self-organising is not merely a process occurring without guidance but happens despite it (Cairney 2020), often leading to nonlinear development and unexpected outcomes (Marks and Gerrits 2013). Therefore, policy-making does not always follow the ideal of rational decision-making, and understanding the parts is not enough to understand the whole, and that is why understanding nonlinearity can be seen as part of the core of understanding complex systems (Morçöl 2012).

Second, actors in complex systems have co-evolutionary relationships with their environment. In sport policy, policymakers and administrators adapt to and shape their environments simultaneously, leading to limited operational options even for powerful individual actors (Bovaird 2008, Teisman and Klijn 2008). Third, complex systems are open to socially constructed boundaries, that are formed and operates under the orders of certain boundary conditions that together govern and influence the functioning of the system (Morçöl and Wachhaus 2009, Rhodes et al. 2011). These include legislation, policies, values, governance structures and social norms (Rhodes et al. 2011). Complex systems also operate in complex environments where challenges are intertwined and there is no single right solution and solving problems requires cooperation. In sport policy, new phenomena arise, and existing phenomena evolve across the interfaces

of politics, economics, technology, and culture. These phenomena often challenge existing knowledge and produce conflicting interpretations.

Systems approach in the field of sport policy has already proven valuable, especially from the perspective of promoting physical activity (PA) (see Rutter et al. 2019, Nau et al. 2022). A more structured understanding of the current research combining systems approach and sport policy necessitates a comprehensive review of relevant studies. This scoping review aims to fill this gap by identifying and characterising the use of systems approach in sport policy research, addressing the following two research questions: What type of research has been conducted using systems approach in sport policy? What are the primary benefits and challenges regarding the use of systems approach reported in the study findings? By addressing these questions, we aim to shed light on the ‘broad sense of the state of science’ in this field of research interest (see Peters et al. 2020). Furthermore, we aim to enhance the comprehension regarding the relevance of these methods, thereby aiding future research endeavours in the field of sport policy.

To the best of our knowledge, no reviews have investigated the use of systems approach in sport policies. Astbury et al. (2023) conducted a scoping review of the use of systems approach in policies related to noncommunicable disease prevention. Some scoping reviews have investigated the use of systems approach in PA (see Nau et al. 2022, Littlejohns et al. 2023). However, these reviews do not explicitly focus on the policy dimensions of the topic. Our review differs from those previously conducted in the same field of interest because it focuses on *sport* policy in large scale and not, for instance, only on PA policies.

The structure of this study adheres to the scoping review model. Following the Introduction, we outline the methodological choices and describe the progression of the data selection and analysis processes. Subsequently, we present the results based on the research questions. In the Discussion section, we reflect on the findings and future applications of systems thinking and complexity science to sport policy research.

## Methods

Our study follows the scoping review research tradition developed by Arksey and O'Malley (2005) and Levac et al. (2010). The Joanna Briggs Institute later refined the instructions for conducting a scoping review (Peters

et al. 2020, Pollock et al. 2023). This review was conducted within these guidelines, and the results are reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) statement (see Additional File 1).

Because definitions of concepts are essential in reviews, it is worth clarifying the term 'sport' in particular. By that term we refer to elite, competitive, and recreational sport as well as PA. There is a dichotomy between the concepts of sport and PA (see Ziakas and Beacom 2018). Sport is seen as an organised and structured activity, whereas PA is seen as an unstructured recreational physical expression (Ziakas and Beacom 2018). PA, as a form of sport, is originally a health-oriented concept (Caspersen et al. 1985, Piggin 2020). However, Piggin (2020) suggests that PA should be understood in a more holistic manner, moving away from an excessively health-centred interpretation. This could facilitate communication between different policy sectors and reinforce agenda-setting in sport policies. With the broad definition used in this review, we can comprehensively cover the field of sport more effectively than is typically the case in sport policy research. This broad definition enables us to determine which sport focus areas have been studied in this particular field of research.

We searched for articles in the EBSCOhost, PubMed, and Scopus databases, which are suitable academic search systems for systematic reviews (Gusenbauer and Haddaway 2020). The searches were conducted on 28 February 2024 for all databases. A search strategy was developed to combine three main terms aligned with the research questions. These terms are 'systems approach', 'sport', and 'policy'. Our final search strategy included the following terms: ('systems science\*' OR 'systems analys\*' OR 'systems change\*' OR 'systems thinking' OR 'systems approach\*' OR 'systems-based approach\*' OR 'systems theor\*' OR 'systems perspective\*' OR 'complex systems' OR 'complexity thinking' OR 'complexity science\*' OR 'complexity theor\*') AND (sport\* OR 'physical activity') AND (poli\* OR polit\*). We searched the titles, abstracts, and keywords. We also screened the reference lists of the relevant articles utilising these search terms.

We reviewed the search results in accordance with inclusion and exclusion criteria based on our research aims. The inclusion criteria were: 1) peer-reviewed journal articles published in English from 1 January 2010 to 28 February 2024, with full text available; 2) articles aiming to investigate sport policy (including PA); and 3) articles that identified systems approach as a framework or study method. All three inclusion criteria had to be met for articles to be included. The exclusion criteria were as fol-

lows: 1) articles focusing only partially on sport or PA (e.g., main focus on obesity prevention); and 2) investigations that lacked a clear focus on (sport) policy. An article was excluded if one of the exclusion criteria was met. With this data selection protocol, we were able to collect articles that utilised a systems approach and investigated policies related to sport and PA.

The titles, abstracts, and full texts were independently screened by two researchers (TH and JM, and later TH and SL). Snowball screening of the reference lists of included studies was performed by TH and SL. Discrepancies were resolved through discussion and during title and abstract screening. If there was any uncertainty regarding the article's relevance, a full-text review was performed to assess its validity.

Data were extracted from the included studies to describe their basic characteristics and methods used in the articles. The data extraction stage was conducted using MS Excel. All articles were reviewed by two researchers (TH and SL), who gathered data describing publication information, article type, study aim, policy level (international, national, regional, and local), and sport focus (e.g. elite sport and PA). Information on the methods used in the articles was also collected during the data extraction stage. The characteristics of the sources of evidence are presented in the Characteristics of the data subsection.

We used qualitative content analysis to address the second research question. Qualitative content analysis is the recommended protocol for data analysis in scoping reviews (Pollock et al. 2023). This method entails a descriptive approach to analysis, with the aim of identifying key characteristics or factors related to a concept (Pollock et al. 2023). We adopted an inductive approach to conduct the analysis, which is pertinent owing to the unstructured nature of our data and the absence of an existing framework regarding the application of systems approach in the field of sport policy. Using an inductive approach, our aim was to gather descriptive information on the main benefits and challenges associated with the use of systems approach in sport policy research. The analysis was conducted with the aim of avoiding reinterpretation as it was not consistent with the purpose of a scoping review (Pollock et al. 2023).

Data analysis was conducted by two researchers (TH and SL) using ATLAS.ti software. Open coding, which involves the initial coding of expressions concerning the benefits or challenges associated with the use of systems approach, was conducted individually by both researchers. Subsequently, an initial coding framework comprising five categories was cre-

ated based on open coding. Both researchers revisited the findings of these studies, adapting the previously created codes and classifying them into different categories. The synthesis of the data analysis is presented in the Benefits and challenges regarding the use of systems approach subsection.

## Results

### *Selection of the data*

We identified 502 records in our search. After removing the duplicates, 325 articles were screened. Following the screening of titles and abstracts, 36 papers were initially considered for the full-text review. After going

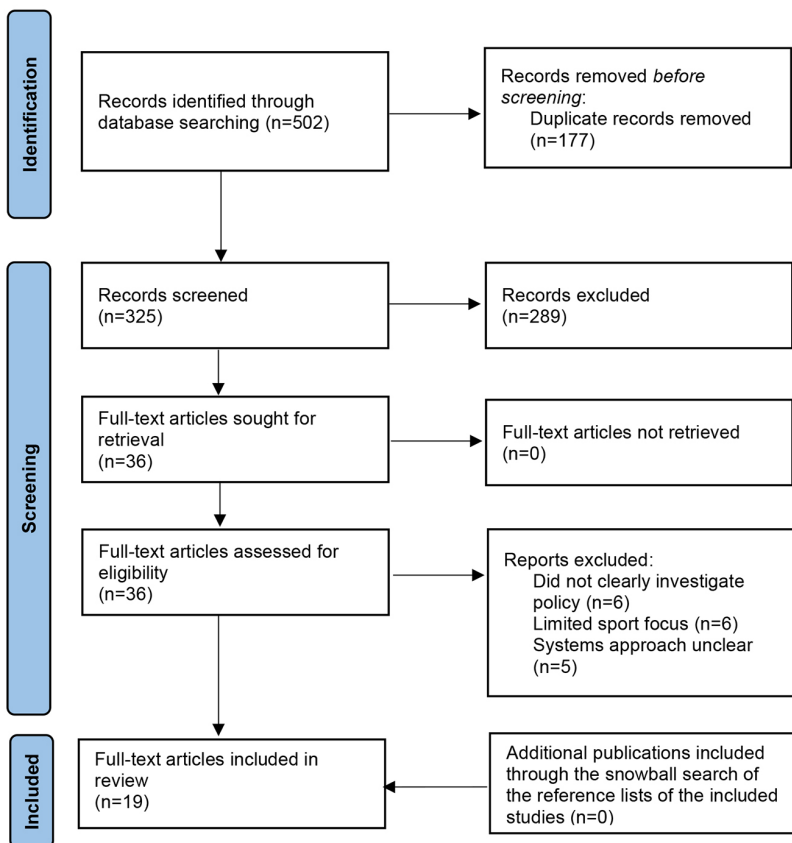


Figure 1. PRISMA flow diagram of the search process.

through the inclusion and exclusion criteria, 17 articles were still excluded from the review process. After this a total of 19 articles were eventually included in the analysis. Figure 1 (p. 183) shows the PRISMA flow diagram depicting the details of publication identification, screening, and inclusion.

### *Characteristics of the data*

Our research data comprised 19 studies, the majority of which were original articles (n=15). From the overall 19 studies which were included in our research data, 17 articles were published in the year 2020 or later. Geographically, the publishing location varied, with Australia (n=5) and the United Kingdom (n=5) being the most active in applying systems approach to sport policy research. The level of policy focus varied among the articles, with the national level being the most commonly studied (n=13). The studies predominantly investigated PA promotion (n=15), with only a few focusing on organised sport (n=4). The basic characteristics of the data are listed in Table 1 (see Appendix).

Table 2 (see Appendix) lists the journals in which these studies were published. Studies focusing on organised sport (n=4) appeared in *Frontiers in Sports and Active Living*, *International Journal of Sport Policy and Politics*, *European Journal for Sport and Society*, and *International Journal of Environmental Research and Public Health*. Studies investigating PA (n=15) were predominantly published in journals with a health-oriented focus.

The use and description of the systems approach methods varied across the articles. Some studies did not precisely elaborate on the use of the systems approach, and the methods used were ambiguously associated with systems thinking and complexity science. Therefore, one study was classified as having an ‘unclear systems approach’ (Volf et al. 2023). We identified a wide variety of methods used in these studies. Predominantly, these methodologies leaned towards qualitative approaches (n=17), with only two studies utilising mixed methods (Volf et al. 2023, Salvo et al. 2021). System mapping (n=8) was the most frequently used method. All studies focusing on organised sport (n=4) were based on systems theory. The data used in the studies were collected primarily from policy documents, literature reviews, and stakeholder interviews and workshops. Additionally, Nau et al. (2021, 2023) utilised existing conceptual frameworks as research data. The methodological details are presented in Table 3 (see Appendix).

In summary, this review is based on peer-reviewed articles that illuminate the application of systems approach in sport policy. Across diverse



national contexts, most of the selected works examine how sport-related policy is shaped, implemented, and evaluated to respond to physical inactivity and broader societal goals. A dominant theme is the move toward *systems approaches*. Multiple studies highlight the need for *cross-sectoral coordination*, identifying critical *policy gaps*, *leverage points*, and governance limitations. Four studies focusing specifically on organised sport systems shed light on elite sport development, institutional legitimacy, and governance. Collectively, the articles reviewed here demonstrate that sport policy is increasingly understood as a multilevel, multidisciplinary enterprise – interwoven with social, legal, cultural, and economic systems that demand integrated, context-sensitive approaches. A more detailed analysis is presented below.

### *Benefits and challenges regarding the use of systems approach*

We classified the expressions regarding the primary benefits and challenges of using systems approach in sport policy research into five categories:

1. understanding current systems,
2. understanding and fostering change,
3. enhancing cross-sectoral collaboration,
4. supporting policies and practices, and
5. surpassing traditional research.

Each category encompassed multiple benefits but also certain challenges regarding the use of system approach. The key characteristics and factors related to these categories are summarised in Table 4 (see Appendix).

*Understanding current systems* was the most typical category and was found in 18 of the 19 articles. The benefits associated with this category were mentioned in 18 articles, and the challenges in 10 articles. The expressions in this category relate to how systems approach can be used to comprehend the context and different levels of underlying influencing factors related to systems<sup>1</sup>. This understanding provides an overview of the current sport policy systems. For instance, Nau et al. (2023) asserted that by mapping the laws affecting PA environments, a baseline picture of how laws currently address PA can be established.

1 Park et al. 2010, Nau et al. 2019, 2021, 2023, Bellew et al. 2020, Bing 2021, Daly-Smith et al. 2020, Rigby et al. 2020, Guariguata et al. 2021, Jacobs et al. 2021, Murphy et al. 2021, Salvo et al. 2021, Koorts et al. 2022, Nobles et al. 2022, Schreiner et al. 2021, 2022, Volf et al. 2023.

Using systems approach, it is also possible to understand the interactions, relationships, and networks related to sport policies.<sup>2</sup> Schreiner et al. (2022) reported that using systems theory with an organisational theory perspective enabled them to systematically analyse inter-organisational relationships between sports and political organisations. Systems approach can also be used to understand the roles and motivations of organisational- and individual-level actors<sup>3</sup>. Additionally, multiple studies recognised that by using systems approach, they were able to address gaps in understanding and identify potential challenges and opportunities regarding the sport policy system<sup>4</sup>.

Some challenges have also been reported in this category. Some studies have indicated that the overall insight gained from the study was restricted due to the limited focus or data used in the study process<sup>5</sup>. Koorts et al. (2022) reported that one of the main limitations of their study was the absence of relational aspects between actors (see also Daly-Smith et al. 2020).

*Understanding and fostering change* was addressed in 16 articles. The benefits associated with this category were mentioned in 15 articles, and the challenges in 7 articles. The content in this category pertains to the utilisation of systems approach to understand the changes and the changing nature of the systems<sup>6</sup>. For instance, Nobles et al. (2022) reported that systems approach is helpful for capturing the wider impacts of policy programmes over time. Systems approach can also be useful for building an understanding of organisational changes (see Park et al. 2010, Schreiner et al. 2022). Park et al. (2010) utilised Burke's systems theory of organisational change to provide insights into how organisations respond to new opportunities and initiatives. Using systems approach, researchers can understand the complex and contextually varying consequences of policy actions<sup>7</sup>. Nobles et al. (2022) reported that they could capture both the anticipated and unanticipated impacts of PA promotion programmes. Simi-

2 Park et al. 2010, Nau et al. 2019, 2023, Daly-Smith et al. 2020, Bing 2021, Guariguata et al. 2021, Schreiner et al. 2021, 2022, Koorts et al. 2022, Rigby et al. 2022.

3 Nau et al. 2019, Bellew et al. 2020, Daly-Smith et al. 2020, Schreiner et al. 2021, 2022, Nobles et al. 2022, Rigby et al. 2022.

4 Nau et al. 2019, 2021, 2023, Bellew et al. 2020, Daly-Smith et al. 2020, Rigby et al. 2020, Guariguata et al. 2021, Volf et al. 2023.

5 Nau et al. 2019, 2023, Jacobs et al. 2021, Murphy et al. 2021, Salvo et al. 2021, Schreiner et al. 2021, 2022, Nobles et al. 2022.

6 Nau et al. 2019, 2021, Bing 2021, Jacobs et al. 2021, Salvo et al. 2021, Koorts et al. 2022, Nobles et al. 2022.

7 Guariguata et al. 2021, Nau et al. 2021, Salvo et al. 2021, Nobles et al. 2022, Volf et al. 2023.

larly, Salvo et al. (2021) recommend using systems approach to minimise the risk of possible unintended impacts of the PA promotion policy.

Based on the articles, systems approach can also be beneficial when the goal is to foster and reinforce system changes, aiming to shift the sport policy system to a more desirable state<sup>8</sup>. Some studies have also indicated that with systems approach, it is possible to highlight the need for the re-organisation of systems operations and reveal the factors needed to make that change<sup>9</sup>. For example, Daly-Smith et al. (2020) encouraged a shift in the decision-making paradigm as new challenges emerge. New skills and ways of working are required for this change (see Rigby et al. 2020).

Certain challenges have been mentioned in this category. Capturing changes in sport policy systems has been reported to be challenging in some studies<sup>10</sup>. Nau et al. (2023) noted that their data only reflected the state of the legal system at the time of assessment. Achieving changes in systems at a practical level has also been reported to be difficult, especially when attempting to obtain changes with greater influence<sup>11</sup>. As Koorts et al. (2022) noted, leverage points with the greatest potential for a desirable system change are related to stakeholders' goals and beliefs, which are the most difficult to change.

*Enhancing cross-sectoral collaboration* was found in 14 of the 19 articles. The benefits associated with this category were mentioned in 14 articles, and the challenges in 6 articles. This category was particularly evident in studies using stakeholder workshops and contained expressions about the benefits of using systems approach to increase and enable cross-sectoral collaboration<sup>12</sup>. Eight of the studies in our data set arranged stakeholder workshops as part of their research process (see Table 2), providing a way to bring actors from different sectors together to discuss issues regarding sport policy (see e.g., Rigby et al. 2020, Murphy et al. 2021). Rigby et al. (2020) reported that their workshop provided a platform for researchers, practitioners, and policymakers to collectively explore the complexity of local decision-making systems and identify mechanisms to deal with it.

8 Bellew et al. 2020, Daly-Smith et al. 2020, Guariguata et al. 2021, Jacobs et al. 2021, Koorts et al. 2022, Rigby et al. 2022.

9 Park et al. 2010, Daly-Smith et al. 2020, Rigby et al. 2020, 2022, Nau et al. 2021, Salvo et al. 2021).

10 Guariguata et al. 2021, Koorts et al. 2022, Nau et al. 2023.

11 Guariguata et al. 2021, Salvo et al. 2021, Koorts et al. 2022, Nobles et al. 2022, Rigby et al. 2022.

12 Nau et al. 2019, 2021, 2023, Bellew et al. 2020, Daly-Smith et al. 2020, Rigby et al. 2020, 2022, Guariguata et al. 2021, Milton et al. 2021, Murphy et al. 2021, Koorts et al. 2022, Nobles et al. 2022, Schreiner et al. 2022, Volf et al. 2023.

Platforms created for collaboration can generate opportunities to solve discrepancies, share views and knowledge, build cohesion, and foster shared understanding among stakeholders<sup>13</sup>. According to Rigby et al. (2020), arranging cross-sectoral workshops can offer valuable opportunities to disrupt working methods and confront different rationalities among stakeholder groups. Murphy et al. (2021) reported that their research process helped clarify the roles of different stakeholders in the PA policy system. Using systems approach, such as system dynamics modelling, can also be beneficial for reducing the duplication of effort in the sport policy system (Koorts et al. 2022).

Studies have also highlighted challenges related to cross-sectoral collaboration. Building a shared understanding can be arduous at the practical level (Koorts et al. 2022, Nobles et al. 2022). Engaging a wide spectrum of possible relevant stakeholders from the field of interest is challenging, and some significant actors may be omitted from the collaboration process (see e.g., Koorts et al. 2022). It is possible that a particular viewpoint or sector is overrepresented in stakeholder collaboration, even if the study is conducted using a multi-sectoral approach<sup>14</sup>.

*Supporting policy and practice* emerged as a prominent category, with codes found in 16 of the articles. The benefits associated with this category were mentioned in 16 and challenges in 8 of the articles. Through the application of systems approach, sport policy scholars can conduct research with practical utility, aiding policymakers in addressing complex issues<sup>15</sup>. For instance, Jacobs et al. (2021) noted that their findings could aid in the effectiveness of the implementation phase of elite sporting policies. Research based on systems approach can provide tools, recommendations, and guidance for policymakers to strengthen their self-awareness of policy systems and to conduct more successful and comprehensive policy actions<sup>16</sup>. For example, Guariguata et al. (2021) suggested that group model-building processes involving stakeholders from various sectors provide a tool to guide priority setting and policy planning.

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13 Nau et al. 2019, 2023, Daly-Smith et al. 2020, Guariguata et al. 2021, Rigby et al. 2020, 2022, Milton et al. 2021, Murphy et al. 2021, Koorts et al. 2022, Nobles et al. 2022.

14 Daly-Smith et al. 2020, Guariguata et al. 2021, Murphy et al. 2021, Koorts et al. 2022, Nobles et al. 2022, Rigby et al. 2022, Volf et al. 2023.

15 Nau et al. 2019, 2021, 2023, Bellew et al. 2020, Daly-Smith et al. 2020, Rigby et al. 2020, 2022, Guariguata et al. 2021, Jacobs et al. 2021, Milton et al. 2021, Murphy et al. 2021, Schreiner et al. 2021, Koorts et al. 2022, Nobles et al. 2022, Volf et al. 2023.

16 Bellew et al. 2020, Daly-Smith et al. 2020, Guariguata et al. 2021, Milton et al. 2021, Nau et al. 2021, 2023, Salvo et al. 2021, Koorts et al. 2022, Volf et al. 2023.

One concrete way in which systems approach can enhance the effectiveness of sport policies is by addressing potential policy actions<sup>17</sup>. For instance, Koorts et al. (2022) highlighted 10 potential leverage points that influence youth active recreation. Research that uses systems approach to support policies and practices can promote desired policy outcomes. Some studies have specifically emphasised that systems approach provide a means to enhance the population levels of PA<sup>18</sup>.

However, data suggest a gap between research using systems approach and practical applications<sup>19</sup>. Solutions and recommendations derived from systems thinking and complexity science may prove challenging to implement in practice<sup>20</sup>. Rigby et al. (2020) reported that some stakeholder groups participating in workshops discussed difficulties in attaining and evaluating holistic interventions. Furthermore, some studies indicated that the practical utility of systems approach-based research is questionable in certain cases<sup>21</sup>. Rigby et al. (2020, 2022) also highlighted a potential conflict between the rapid reality of decision-making processes and the often slow pace of research-evidence generation.

*Surpassing traditional research* was a category with codes found in 16 of the articles. The benefits associated with this category were mentioned in 14 articles, and the challenges in 6. Expressions in this category imply that systems thinking and complexity science can be viewed as a more holistically oriented approach, providing new possibilities for sport policy<sup>22</sup>. Using these approaches, it is possible to surpass previous sport policy research and traditional perspectives<sup>23</sup>. According to Bing (2021), learning based on the complex system paradigm provides an alternative to traditional reductionist approaches used in sport policy research. Similarly,

17 Nau et al. 2019, 2021, 2023, Bellew et al. 2020, Daly-Smith et al. 2020, Guariguata et al. 2021, Murphy et al. 2021, Nau et al. 2021, Koorts et al. 2022, Nobles et al. 2022, Volf et al. 2023.

18 Nau et al. 2019, 2021, Daly-Smith et al. 2020, Milton et al. 2021, Murphy et al. 2021, Salvo et al. 2021, Koorts et al. 2022.

19 Bellew et al. 2020, Rigby et al. 2020, 2022, Guariguata et al. 2021, Salvo et al. 2021, Koorts et al. 2022, Nau et al. 2023, Volf et al. 2023.

20 Bellew et al. 2020, Rigby et al. 2020, 2022, Guariguata et al. 2021, Koorts et al. 2022.

21 Guariguata et al. 2021, Salvo et al. 2021, Rigby et al. 2022, Nau et al. 2023, Volf et al. 2023.

22 Park et al. 2010, Bellew et al. 2020, Daly-Smith et al. 2020, Bing 2021, Murphy et al. 2021, Nau et al. 2021, Salvo et al. 2021, Schreiner et al. 2021, Koorts et al. 2022, Rigby et al. 2022.

23 Daly-Smith et al. 2020, Bing 2021, Guariguata et al. 2021, Jacobs et al. 2021, Milton et al. 2021, Murphy et al. 2021, Nau et al. 2021, Salvo et al. 2021, Koorts et al. 2022, Rigby et al. 2022.

Koorts et al. (2022) saw that systems analysis methods move beyond the limited cause-effect models traditionally used in PA promotion research.

However, these traditional approaches and deeply rooted mindsets are difficult to change in practice (Nobles et al. 2022, Rigby et al. 2022). Studies have indicated a lack of familiarity with systems thinking and complex science methodologies and concepts at a practical level (Guariguata et al. 2021, Nobles et al. 2022, Rigby et al. 2022). Using systems approach methods can also be resource-demanding, and as an emerging field, these methodologies require further development (see Bellew et al. 2020, Guariguata et al. 2021, Nobles et al. 2022, Schreiner et al. 2022).

## Discussion

This scoping review identifies and characterises the use of systems thinking and complexity science in sport policy research. Nineteen articles were included in our review, revealing that systems approach is seldom used in sport policy research. However, our results reveal that the number of publications on these studies has increased significantly in recent years. Only two articles included in our data were published before 2020 (Park et al. 2010, Nau et al. 2019), revealing a growing interest in systems approach in sport policy research. This growing interest has also been observed in other PA- and sport-focused studies (see McLean et al. 2021, Nau et al. 2022). It can be assumed that this trend in sport policy research will continue to develop, and systems approach will gain ground in the near future. Therefore, understanding the use of systems approach, including its potential possibilities and pitfalls, in the context of sport policy research is imperative. Our review contributes to this understanding by presenting the key characteristics and the main benefits and challenges related to the use of systems approach in the field of sport policy research.

### *Tendency towards PA promotion*

Our findings clearly showed that promoting PA is the primary focus area when using a systems approach to examine sport policies. Only four out of 19 studies in our data used systems approach for studying organised sports. The emphasised tendency towards PA promotion research can be perceived as logical because of the globally increased interest in addressing the ‘global pandemic of physical inactivity’ (see Kohl et al. 2012). The fact

that the World Health Organization (WHO 2018, p. 8) has recommended the use of systems approach to address the complex issue of inadequate levels of PA is clearly one of the main reasons for this increased research interest in the field of PA policy (see Nau et al. 2022). From a public policy perspective, PA is strongly associated with health promotion and policies (see Steenberger 2001, Piggin 2020). PA can be viewed as a natural object for achieving public policy goals involving the aims of the social good.

This suggests that the use of systems approach in sport and PA policy research leans towards health policies rather than general sport policies. Public sport policy interests strongly attached to PA promotion can be seen as problematic in the comprehensive development of sport policy research. Surpassing generally used sport science research methods criticised for being reductionist (see Salmon and McLean 2019) implies that sport policy researchers and public policy practitioners should develop sport policy in ways that cover all forms of sporting activity, not only PA promotion.

### *Key factors related to the methodologies*

Systems approach has been heterogeneously used in sport policy research. Studies reviewed in this article have utilised various approaches, of which system mapping is the most commonly used. Despite such ambiguity, our data show that using systems approach to study sport policies is considered highly beneficial by the researchers of this field of interest. According to our analysis, researchers can provide contextually tailored and comprehensive views on the current status of sport policy systems by using systems approach.

Systems approach also offers a way to comprehend the changes and identify points of intervention in sport policy systems (cf. Meadows 1999). This dynamic form of understanding is valuable when attempting to understand the nonlinear and potentially unexpected consequences of complex policy actions (Cairney 2012, Marks and Gerrits 2013) and the influence of networks (Morçöl and Wachhaus 2009). Systems approach is also considered effective in conducting cooperative research and facilitating fruitful cross-sectoral collaboration among stakeholders in sport policy systems. Systems approach can provide valuable methods for understanding the existing interactions and collaboration among stakeholders (Peters 2014). Using systems approach, researchers can also provide evidence-based tools, recommendations, and guidance for political decision-making.



ers, which can lead to more comprehensive policy actions with potentially more sustainable outcomes in sport practice.

However, utilising systems approach in sport policy research presents several challenges. Our analysis showed that it is challenging to meet the requirements for obtaining evidence as comprehensively as possible. The perspectives, data, and methods used should be rich and diverse, which means that systems approach-based research may be resource-demanding (see also McLean et al. 2025). The practical use of the evidence obtained through systems approach also seems to have complications. The possible solutions suggested can be complex and targeted towards parts of sport policy systems that are difficult to change.

In our research data, studies utilising systems approach often aim to enhance collaboration which is not without challenges. The main challenge regarding cross-sectoral collaboration observed in our data analysis concerns representation. When conducting research with collaborative aims, it may be difficult to engage all relevant stakeholders to participate, leading to the possible overrepresentation of certain sectors. Additionally, the new concepts and ways of thinking may seem complicated at the practical level due to unfamiliarity with systems approach, constituting a central problem for the use of these new methods in sport policy research (see Rigby et al. 2022). As an emerging tradition in sport policy research, systems approach requires further methodological development. Nguyen et al. (2023) also pointed out the need for further development of concepts and tools in systems thinking to facilitate their acceptance at the practical level.

While our review highlights the many advantages of using systems approach in sport policy research, it is important to acknowledge that our own synthesis is not unproblematic. The analysis presented here is based primarily on how the authors of the reviewed articles themselves assessed the strengths and challenges of the systems approach. It is therefore likely that the benefits have been somewhat amplified, while more fundamental critiques of the approach, particularly from scholars working within other methodological or theoretical traditions, have remained absent. As such, the findings should not be read as a neutral evaluation of systems approach in sport policy research, but rather as a characterisation of how this approach has been applied and understood within its own growing community. Future work would benefit from more comparative perspectives that juxtapose systems approach with alternative frameworks, thereby enabling a more pluralistic and critical assessment of its added value, limitations, and place within the broader landscape of sport policy research.



### *Limitations of the scoping review*

It should be recognised that this scoping review has some limitations. First, the articles included in our research data varied in terms of quality. We did not conduct a critical appraisal of the sources of evidence used because this is generally not recommended in scoping reviews, as the aim is to map the available evidence more broadly (see Peters et al. 2020). However, the somewhat heterogeneous nature of the data used posed challenges for the analysis of the articles and, in particular, for the evaluation of the systems approach. This problem was addressed through collaboration between the researchers who contributed to this study. Second, the data search was limited to English. Therefore, some relevant studies might have been excluded from this review.

## Conclusions

This scoping review identified and characterised the use of systems thinking and complexity science methods in sport policy research. Overall, research on sport using systems approaches is developing rapidly and is likely to continue growing in the near future. Our findings revealed that research in this area is currently limited and predominantly focused on PA promotion policies, rather than comprehensively addressing sport policy as a whole or other policy domains such as elite sports. These gaps point to important directions for future research.

Ultimately, a key question is what systems thinking and complexity science bring to the study of sport policy that previous theories have not offered. Systems thinking and complexity science approaches have been accused of being too abstract, and their origins in the natural sciences have been questioned in terms of their applicability in social and administrative sciences (Nguyen et al. 2023, Jalonon 2024). Theories should be treated with caution in research, so that the researcher does not become bogged down in the system or complexity trap. It is also evident that adopting systems approach to sport policy research is not a panacea, which overpasses the traditional policy theories (cf. Lehtonen et al. 2025).

However, our results suggest that systems approach holds considerable promise for sport policy research. It makes it possible to understand change and events in social systems where interdependence and interaction are high, but predictability of system outcomes, like policy systems, is low (see Day & Hunt 2023). A key advantage of the systems approach

in sport policy research is that it enables a deeper understanding of concepts such as nonlinearity, self-organisation and emergence. While these approaches provide clear benefits, our review also highlights important methodological challenges, indicating that systems approach is not without its limitations. Future research should adopt these methods with critical awareness, carefully weighing their potential and limitations. In doing so, researchers can expand the conceptual “toolbox” of sport policy studies, promote theoretical diversity, and contribute to a more nuanced and effective understanding of policy development in the sport domain.

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# Appendix

**Table 1.** *Basic characteristics of the research data* | Page 201

**Table 2.** *The journals in which the articles have been published* | Page 204

**Table 3.** *Methods used in the research articles* | Page 205

**Table 4.** *Categories including the main benefits and challenges regarding the use of systems approaches in sport policy research* | Page 207

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist | Page 209

Table 1. Basic characteristics of the research data.

| Author and publication year | Country      | Type of article  | Aim of the study                                                                                                                                                                                                                                                                                                                                                   | Policy level | Sport focus                     |
|-----------------------------|--------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|---------------------------------|
| Murphy et al. 2021          | Ireland      | Research article | The study aimed to facilitate a systems approach for identifying current good practice and gaps in promoting physical activity (PA) in Ireland. It sought to align existing Irish policies with the Global Action Plan on Physical Activity (GAPPA) and determine areas of progress that could be strengthened, as well as policy opportunities and practice gaps. | National     | PA                              |
| Koorts et al. 2022          | Australia    | Research article | The study aimed to use systems analysis methods to understand youth active recreation in Victoria, Australia, identify potential system leverage points to enhance active recreation, and explore stakeholder views of systems analysis methods for informing practice and policy decision-making.                                                                 | Regional     | PA                              |
| Volf et al. 2023            | Ireland      | Research article | The study aimed to identify critical implementation gaps by assessing the extent of PA policy implementation in the Re-public of Ireland and to identify and prioritize actions that can strengthen policy implementation in Ireland.                                                                                                                              | National     | PA                              |
| Rigby et al. 2020           | UK           | Research article | The study aimed to identify what the role of stakeholders in implementing PA policy is locally, and how this can be optimised.                                                                                                                                                                                                                                     | Local        | PA                              |
| Jacobs et al. 2021          | South Africa | Research article | The study aimed to contribute to the understanding of how contextual factors can influence the elite sporting system of South Africa (SA).                                                                                                                                                                                                                         | National     | Elite sport                     |
| Schreiner et al. 2022       | Germany      | Research article | The study aimed to understand how governmental, and sports organisations exactly coordinate joint SDP projects and how both of them ensure that their own interests are considered.                                                                                                                                                                                | National     | Sport for Development and Peace |

|                          |           |                           |                                                                                                                                                                                                                                                                                                                                                |                               |                                    |
|--------------------------|-----------|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|------------------------------------|
| Milton et al.<br>2021    | UK        | Public health<br>practice | The study aimed to briefly introduce each investment area and reflect on how the updated document can be used to develop and support a clear physical activity advocacy strategy.                                                                                                                                                              | International and<br>national | PA                                 |
| Nau et al.<br>2021       | Australia | Policy and practice       | The study aimed to propose a framework of legal strategies for increasing physical activity and provide examples of how these align with the WHO Global Plan policy objectives.                                                                                                                                                                | All levels                    | PA                                 |
| Nau et al.<br>2023       | Australia | Research article          | The study aimed to establish a baseline assessment of how laws currently address walking and cycling, and how they compare across Australian states and territories.                                                                                                                                                                           | Regional                      | PA                                 |
| Schreiner et al.<br>2021 | Germany   | Research article          | The study aimed to investigate the effect of United Nations' recommendations and the endeavors of national sports organisations on Sport for Development and Peace (SDP) as used in German development policy.                                                                                                                                 | International and<br>national | Sport for Development and<br>Peace |
| Nobles et al.<br>2022    | UK        | Research article          | The study aimed to identify the strategies which supported the implementation of We Can Move (WCM) and highlight the barriers to WCM being implemented.                                                                                                                                                                                        | Local                         | PA                                 |
| Salvo et al.<br>2021     | USA       | Research article          | The study aimed to examine the potential benefits of large-scale physical activity promotion strategies on Sustainable Development Goals (SDG).                                                                                                                                                                                                | International                 | PA                                 |
| Bing,<br>2021            | Korea     | Research article          | The study aimed to reinterpret the history of Korean Baseball Organization (KBO) League by applying a complex paradigm with a sociopolitical approach.                                                                                                                                                                                         | National                      | Elite Sport                        |
| Guariguata et al. 2021   | Jamaica   | Policy and practice       | The study aimed to explore the use of systems thinking, specifically through group model building, to develop a causal loop diagram that describes the system driving increasing physical inactivity in the Caribbean region and to identify the most effective ways of intervening in that system to encourage and promote physical activity. | Regional                      | PA                                 |

|                           |           |                  |                                                                                                                                                                                                                               |                       |    |
|---------------------------|-----------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|----|
| Park et al.<br>2010       | USA       | Research article | The study aimed to evaluate the impact of the National Blueprint (NB) on the PA related policies, programs, and organizational culture of selected national organizations.                                                    | National              | PA |
| Rigby et al.<br>2022      | UK        | Research article | The study aimed to give critique for the key elements of complexity theory and consider how it is understood and put into practice in PA policy-making.                                                                       | National              | PA |
| Nau et al.<br>2019        | Australia | Research article | The study aimed to report the findings of the audit and reveals how PA has been addressed and embedded within the policies of different sectors and jurisdictions.                                                            | National and regional | PA |
| Daly-Smith et al.<br>2020 | UK        | Research article | The study aimed to co-develop a whole-school physical activity framework (Creating Active Schools) with multiple stakeholders, using the double diamond design approach (DDDA).                                               | National              | PA |
| Bellew et al.<br>2020     | Australia | Brief report     | The study aimed to describe the ASAPa project goals and objectives and progress to date. An initial PA system conceptual map for Australia was presented, and related strategic challenges and research needs were discussed. | National              | PA |

**Table 2.** *The journals in which the articles have been published.*

| Journal                                                             | Number<br>of articles |
|---------------------------------------------------------------------|-----------------------|
| Journal of Physical Activity and Health                             | 5                     |
| International Journal of Behavioral Nutrition and Physical Activity | 2                     |
| Health Research Policy and Systems                                  | 2                     |
| BMC Public Health                                                   | 2                     |
| Bulletin of the World Health Organization                           | 2                     |
| Frontiers in Sports and Active Living                               | 1                     |
| International Journal of Sport Policy and Politics                  | 1                     |
| European Journal for Sport and Society                              | 1                     |
| BMJ Open                                                            | 1                     |
| International Journal of Environmental Research and Public Health   | 1                     |
| Journal of Aging and Physical Activity                              | 1                     |
| Total                                                               | 19                    |

**Table 3.** *Methods used in the research articles.*

| Author and publication year | Systems approach                 | Methods                                                                                                                | Used data                                                     |
|-----------------------------|----------------------------------|------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|
| Murphy et al. 2021          | System mapping                   | Qualitative, Participatory action research, utilising WHO GAPPA Framework                                              | Policy documents, Stakeholder workshops                       |
| Koorts et al. 2022          | System modelling, System mapping | Qualitative, Umbrella review of systematic reviews, Actor-Map and ActivMaps, Causal loop diagrams, Action Scales Model | Literature review, Stakeholder interviews                     |
| Volf et al. 2023            | Unclear systems approach         | Mixed method, Policy analysis based on the Physical Activity Environment Policy Index (PA-EPI)                         | Policy documents, Survey and interviews, Stakeholder workshop |
| Rigby et al. 2020           | Network analysis                 | Qualitative, the Fuse model/ Fuse PAN workshops                                                                        | Stakeholder workshops                                         |
| Jacobs et al. 2021          | Open systems theory              | Qualitative, Thematic analysis                                                                                         | Stakeholder interviews                                        |
| Schreiner et al. 2022       | Luhmann's systems theory         | Qualitative, Content analysis                                                                                          | Interviews                                                    |
| Milton et al. 2021          | System mapping                   | Qualitative, Utilizing WHO GAPPA framework and ISPAH's Eight Investments That Work for Physical Activity               | Non systematic literature review                              |
| Nau et al. 2021             | System mapping                   | Qualitative, Legal mapping                                                                                             | Conceptual frameworks, WHO GAPPA framework                    |
| Nau et al. 2023             | System mapping                   | Qualitative, Legal mapping                                                                                             | State or regional level laws                                  |
| Schreiner et al. 2021       | Luhmann's systems theory         | Qualitative, Content analysis                                                                                          | Policy documents                                              |
| Nobles et al. 2022          | System mapping                   | Qualitative, Ripple Effects Mapping, Content analysis                                                                  | Stakeholder interviews, Stakeholder workshops                 |
| Salvo et al. 2021           | System mapping                   | Mixed method, Conceptual linkage exercise, Scoping review, Agent-based modeling                                        | Stakeholder workshop, Research literature                     |
| Bing. 2021                  | Complex system theory            | Qualitative, Historical analysis                                                                                       | Research literature, News articles                            |

|                           |                                                             |                                                                                              |                                                       |
|---------------------------|-------------------------------------------------------------|----------------------------------------------------------------------------------------------|-------------------------------------------------------|
| Guariguata et al.<br>2021 | Causal loop<br>diagram                                      | Qualitative, Group model<br>building workshops                                               | Stakeholder inter-<br>views, Stakeholder<br>workshops |
| Park et al.<br>2010       | Burke's sys-<br>tem theory of<br>organisation-<br>al change | Qualitative, the analytic<br>induction approach                                              | Interviews,<br>Organisational<br>documents            |
| Rigby et al.<br>2022      | Complexity<br>theory                                        | Qualitative, Inductive<br>thematic analysis                                                  | Interviews                                            |
| Nau et al.<br>2019        | Cognitive<br>map                                            | Qualitative, Policy audit                                                                    | Policy documents,<br>Stakeholder<br>workshops         |
| Daly-Smith et al.<br>2020 | Complex<br>adaptive<br>systems                              | Qualitative, Experience-based<br>co-design methodology:<br>Double diamond design<br>approach | Stakeholder work-<br>shops, Online<br>questionnaire   |
| Bellew et al.<br>2020     | System<br>mapping                                           | Qualitative, National audit and<br>gap analysis                                              | Policy documents,<br>Stakeholder<br>meetings          |



**Table 4.** *Categories including the main benefits and challenges regarding the use of systems approaches in sport policy research*

|                                           | Benefits                                                                                                                                                                                                        | Challenges                                                                                                                                                             |
|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Understanding current systems</b>      | Understanding sport-related systems by providing an overview of current system boundaries and existing structures. Building understanding of different contexts and influencing factors related to the systems. | Particular studies reported using limited focus and data (e.g., only focusing on macro-level contextual factors), and absence or failure of identifying relationships. |
|                                           | Identifying interactions by recognising relations and networks between different entities, organizations, and actors. Understanding different roles and motivations of actors.                                  |                                                                                                                                                                        |
|                                           | Addressing gaps in understanding. Identifying potential challenges and opportunities regarding sport policy system.                                                                                             |                                                                                                                                                                        |
| <b>Understanding and fostering change</b> | Understanding the changing nature of the sport policy systems. Identifying changes in the systems over time.                                                                                                    | Particular studies reported challenges in capturing the changes.                                                                                                       |
|                                           | Providing insights about organizational changes.                                                                                                                                                                |                                                                                                                                                                        |
|                                           | Predicting and analysing potential consequences. Minimising the risk of unintended impacts by understanding complex and context-specific causalities.                                                           | Achieving system-level changes with greater influence is difficult.                                                                                                    |
|                                           | Fostering systems change by identifying the need for reorganization of systems operations and factors needed to make changes in the sport policy system.                                                        |                                                                                                                                                                        |

|                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                         |
|-----------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Enhancing cross-sectoral collaboration</b> | <p>Increasing and encouraging cross-sectoral communication and collaboration among stakeholders.</p> <p>Enabling conversation and promoting opportunities for collaborative work. Creating platforms for discussion.</p> <p>Generating opportunities to solve discrepancies between stakeholders. Building cohesion by collating and confronting different rationalities.</p> <p>Building shared understanding through interaction. Sharing views and knowledge across sectors. Bringing up possibilities to develop shared vision and avoid duplication of effort.</p>                                                                                         | <p>Challenges to build shared understanding and reduce duplication of effort in practice.</p> <p>The possibility that a particular viewpoint or sector is overrepresented in stakeholder collaboration. Challenge to identify and engage all relevant stakeholders.</p> |
| <b>Supporting policy and practice</b>         | <p>Promoting policy implementation and action by conducting research with practical-level utility.</p> <p>Aiding and informing decision-making and helping policy-makers to navigate through complex issues. Enhancing policy-makers' self-awareness of the policy system.</p> <p>Providing tools, recommendations, and guidance that can be used for more successful and comprehensive policy-making.</p> <p>Increasing the effectiveness of policy implementation with concrete examples of possible policy actions. Identifying intervention points with high potential to affect the system.</p> <p>Promoting and facilitating population levels of PA.</p> | <p>Evidence-based policy recommendations and possible solutions suggested are often hard to achieve at practical level.</p> <p>A gap between the rapid reality of political decision-making and slow research process.</p>                                              |
| <b>Surpassing traditional research</b>        | <p>Systems approaches as a way to re-imagine the systems and provide a more holistic understanding.</p> <p>Identifying new approaches and possibilities for addressing sport policy systems.</p> <p>Surpassing traditional research and knowledge with more comprehensive and broader perspectives. Exceeding previous framing-based views and focusing not only on the direct but also indirect effects of interventions.</p>                                                                                                                                                                                                                                  | <p>Traditional approaches and mindsets can be difficult to change.</p> <p>The lack of familiarity with systems approaches and concepts related to complexity at a practical level.</p>                                                                                  |

**Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist**

| SECTION                   | ITEM | PRISMA-ScR CHECKLIST ITEM                                                                                                                                                                                                                                                 | REPORTED ON PAGE #                                                                               |
|---------------------------|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| <b>TITLE</b>              |      |                                                                                                                                                                                                                                                                           |                                                                                                  |
| Title                     | 1    | Identify the report as a scoping review.                                                                                                                                                                                                                                  | Title: Systems Thinking and Complexity Science in Sport Policy: A Scoping Review of the Research |
| <b>ABSTRACT</b>           |      |                                                                                                                                                                                                                                                                           |                                                                                                  |
| Structured summary        | 2    | Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.                                             | Abstract                                                                                         |
| <b>INTRODUCTION</b>       |      |                                                                                                                                                                                                                                                                           |                                                                                                  |
| Rationale                 | 3    | Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.                                                                                                  | Introduction                                                                                     |
| Objectives                | 4    | Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives. | Introduction                                                                                     |
| <b>METHODS</b>            |      |                                                                                                                                                                                                                                                                           |                                                                                                  |
| Protocol and registration | 5    | Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.                                                                            | n/a                                                                                              |
| Eligibility criteria      | 6    | Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.                                                                                                      | The number of articles and inclusion and exclusion criteria explained in Methods section         |
| Information sources*      | 7    | Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.                                                                 | Databases and timeline of the search strategy explained in Methods section                       |
| Search                    | 8    | Present the full electronic                                                                                                                                                                                                                                               | The search strategy explained in                                                                 |



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| SECTION                                               | ITEM | PRISMA-ScR CHECKLIST ITEM                                                                                                                                                                                                                                                                                  | REPORTED ON PAGE #                                         |
|-------------------------------------------------------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
|                                                       |      | search strategy for at least 1 database, including any limits used, such that it could be repeated.                                                                                                                                                                                                        | Methods section                                            |
| Selection of sources of evidence†                     | 9    | State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.                                                                                                                                                                                      | The overall screening process explained in Methods section |
| Data charting process‡                                | 10   | Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators. | Data charting process in Methods section                   |
| Data items                                            | 11   | List and define all variables for which data were sought and any assumptions and simplifications made.                                                                                                                                                                                                     | Data charting process in Methods section                   |
| Critical appraisal of individual sources of evidence§ | 12   | If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).                                                                                                      | n/a                                                        |
| Synthesis of results                                  | 13   | Describe the methods of handling and summarizing the data that were charted.                                                                                                                                                                                                                               | The summarizing process explained in Methods section       |
| <b>RESULTS</b>                                        |      |                                                                                                                                                                                                                                                                                                            |                                                            |
| Selection of sources of evidence                      | 14   | Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.                                                                                                                               | Figure 1.                                                  |
| Characteristics of sources of evidence                | 15   | For each source of evidence, present characteristics for which data were charted and provide the citations.                                                                                                                                                                                                | Tables 1-3.                                                |
| Critical appraisal within sources of evidence         | 16   | If done, present data on critical appraisal of included sources of evidence (see item 12).                                                                                                                                                                                                                 | n/a                                                        |
| Results of individual sources of evidence             | 17   | For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.                                                                                                                                                                      | Tables 1-3.                                                |
| Synthesis of results                                  | 18   | Summarize and/or present the charting results as they relate to the review questions and objectives.                                                                                                                                                                                                       | Table 4.                                                   |



| SECTION             | ITEM | PRISMA-ScR CHECKLIST ITEM                                                                                                                                                                       | REPORTED ON PAGE #                                                                        |
|---------------------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| <b>DISCUSSION</b>   |      |                                                                                                                                                                                                 |                                                                                           |
| Summary of evidence | 19   | Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups. | Summary and the main results briefly in Discussion                                        |
| Limitations         | 20   | Discuss the limitations of the scoping review process.                                                                                                                                          | Limitations                                                                               |
| Conclusions         | 21   | Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.                                       | Conclusions                                                                               |
| <b>FUNDING</b>      |      |                                                                                                                                                                                                 |                                                                                           |
| Funding             | 22   | Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.                 | This research was supported by the Ministry of Education, Science and Culture of Finland. |

JB1 = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

\* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med*. 2018;169:467–473. doi: [10.7326/M18-0850](https://doi.org/10.7326/M18-0850).



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