BMJ Open

Strengthening active outdoor living among children residing in two disadvantaged neighbourhoods in Copenhagen, Denmark: a mixed methods study protocol for the Happy Healthy Active Children initiative

Maria Stougaard ,[1] Tina Termansen,[1] Nanna Wurr Stjernqvist ,[1] Andrea Skov Borring,[1] Niklas Lynge Villersholt,[1] Nadia Friis,[1] Alberte Laura Oest Müllertz,[2] Peter Elsborg,[2] Sofie Buch Mejsner,[1] Paul Bloch[1]

To cite: Stougaard M, Termansen T, Stjernqvist NW, *et al*. Strengthening active outdoor living among children residing in two disadvantaged neighbourhoods in Copenhagen, Denmark: a mixed methods study protocol for the Happy Healthy Active Children initiative. *BMJ Open* 2026;**16**:e107453. doi:10.1136/bmjopen-2025-107453

► Prepublication history for this paper is available online. To view these files, please visit the journal online (https://doi.org/10.1136/bmjopen-2025-107453).

MS and TT are joint first authors.

Received 04 July 2025
Accepted 17 December 2025

For numbered affiliations see end of article.

Correspondence to
Tina Termansen;
tina.termansen@regionh.dk

ABSTRACT

Introduction The Happy Healthy Active Children (HHAC) initiative is a multicomponent community-based initiative aimed at promoting physical activity, food literacy and nature literacy among children in early childhood kindergarten and primary school settings. Developed in collaboration between Activity Experts and Community Stakeholders, HHAC integrates thematic activities (Play, Nature, Food) across kindergartens, schools and the broader community. The initiative responds to growing concerns about declining physical activity levels, insufficient contact with nature and poor dietary habits in childhood, factors known to influence long-term health and well-being. This protocol outlines the design, implementation and planned evaluation of the HHAC initiative.

Methods and analysis HHAC is carried out within the long-term strategic initiative Tingbjerg Changing Diabetes. Following the Supersetting approach, HHAC addresses inequity in health by mobilising resources across local settings (kindergartens, schools and the local community arenas) and population groups (children, parents, staff and other community members) to develop and implement contextually relevant activities promoting outdoor play, cooking and nature experiences. Activities are evaluated using a within-subject design in kindergartens, while in schools a quasi-experimental design with matched control groups is applied. Data is collected at baseline and follow-up through accelerometry, validated questionnaires and structured observations. Primary outcomes include physical activity levels, food literacy and nature literacy. Analyses apply linear mixed-effects models to account for repeated measures and clustering at the institutional level. The evaluation also investigates implementation processes and context-mechanism configurations through a comprehensive realist evaluation. This includes developing a programme theory, conducting interviews with children, parents, staff and other local stakeholders and participant observations aiming to explore experiences and the mechanisms through which the activities contribute to changes in behaviour and well-being. All data will be analysed and condensed for a model for transferability.

Ethics and dissemination Findings will be disseminated through peer-reviewed journals, conference presentations and public engagement activities targeting educators, policymakers and health professionals. The intervention materials will also be made freely available to support broader implementation. The study procedures were registered and approved by The Capital Region's centre for data reviews 'Videnscenter for Dataanmeldelser' (Reference: P-2023–14277). All procedures were carried out under relevant regulations and guidelines. Written information about the study was given to all school principals, teachers and parents/guardians before the start of the study, and written informed consent is obtained

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The initiative is implemented across multiple settings—kindergartens, schools and local community settings—providing high ecological validity and accommodating everyday conditions for families.
⇒ Activities are co-developed with Community Stakeholders, including educators, health professionals, parents and municipal representatives, enhancing contextual relevance and supporting long-term sustainability.
⇒ The study combines quantitative and qualitative methods, allowing for both outcome measurement and in-depth exploration of mechanisms, implementation processes and contextual influences.
⇒ The study targets disadvantaged neighbourhoods, which require extra efforts and resources to ensure recruitment and reduce risks of stigmatisation.
⇒ The study is limited to selected disadvantaged neighbourhoods in Copenhagen, which may reduce the generalisability of findings to other sociocultural or geographical settings.

from all legal guardians of all participants in their native language prior to child enrolment.

INTRODUCTION

Childhood overweight and obesity affect more than 390 million children and adolescents worldwide. The prevalence has surged in recent decades, leading the WHO to classify childhood obesity as a major public health challenge of the 21st century.[1] In Denmark, 12% of children aged 6–7 years and 18% of children aged 14–15 years are overweight or obese.[2] A major contributing factor to the development of childhood overweight and obesity is insufficient physical activity.[3] Physical activity plays a critical role in developing motor skills in childhood and promoting lifelong active living.[4] However, only 26% of Danish children aged 11–15 years meet the recommended daily minimum of 60 min of moderate-to-vigorous physical activity.[5] Childhood obesity has severe implications for children's physical and mental well-being. Children with obesity are more likely to experience lower quality of life, reduced self-esteem and social stigmatisation, including bullying.[6–8] The Danish Council for Health Promotion and Disease Prevention has reported a significant decline in children's well-being in recent years.[9]

Childhood overweight and obesity is unevenly distributed across socioeconomic population groups.[5] In Denmark, the prevalence of overweight is notably higher among socioeconomically disadvantaged groups with a two to three times higher prevalence among children from families with low income and education levels, unemployment and non-Danish ethnic backgrounds compared with peers from high income families.[10 11] Research shows that children from low socioeconomic backgrounds are generally less likely to participate in organised leisure activities, engage in lower levels of physical activity and experience lower levels of well-being compared with children from more privileged backgrounds.[12–14] This is especially evident in socially disadvantaged neighbourhoods.[15 16]

Multicomponent, settings-based initiatives have proven effective in addressing wicked problems like inequity in health and health behaviour as it mobilises local resources and works to ensure bottom-up context-sensitive activities based on the needs and interests of local communities.[17 18] Research shows that in complex interventions, lasting change across settings is best accomplished through value-based and trusting partnerships.[19–23] However, there remains a significant knowledge gap regarding how to effectively work with structural changes at community level to promote active living in everyday life for families with children. Strategies that prove effective in experimental set-ups often fail to translate into everyday life.[19 24 25] With the ever-persisting challenges of inequity in health, there is a pressing need to test and evaluate such approaches and to build and share knowledge about how to transfer learnings and approaches from one setting to another.[26]

Happy Healthy Active Children (HHAC) is a settings-based initiative that aims to promote health and well-being across settings in disadvantaged urban neighbourhoods in Copenhagen, Denmark. HHAC specifically aims to promote active living among children aged 3–9 years through outdoor activities focusing on play, food and nature. HHAC engages primary schools, after-school clubs, kindergartens, leisure associations and parents in joint efforts to develop and implement activities across settings in two physically connected neighbourhoods. Activities are co-created with and for children, their parents, institutional staff and other local Community Stakeholders to ensure local ownership and contextual and cultural sensitivity.[20 27] Through this collaborative approach, children and parents are to (re)discover the value of playing together, exploring nature and engaging socially with food and meals.

This paper aims to describe the HHAC initiative, including strategies for developing and implementing activities across settings targeting a diverse population group. The protocol also describes the HHAC evaluation strategy combining realist evaluation and effectiveness evaluation.

METHODS

Strategic framework of HHAC

HHAC is carried out within the long-term strategic initiative Tingbjerg Changing Diabetes (TCD).[19] TCD is a community-based health promotion initiative addressing social determinants of health and health inequities in the disadvantaged neighbourhoods of Tingbjerg and Husum, Copenhagen, Denmark. TCD is based on prior experience and research on community participation emphasising the benefits of power sharing, long time frames, higher resourcing costs and long-term partnerships.[19 28] Previous activities of TCD include family cooking classes, collaboration with local farms, community gardening projects, integrated diabetes interventions and various volunteer initiatives, all aimed at enhancing social engagements and promoting health and well-being.[19 28 29]

To address health disparities and prevent type 2 diabetes, TCD uses the Supersetting approach as its foundational strategy.[13] The Supersetting approach is a strategic framework that 'strives to attain synergistic effects through coordinated engagement of multiple stakeholders in multiple settings to mobilise local resources and strengthen social networks for collective community action'.[19] The Supersetting approach does not prescribe specific activities, settings or population groups to be targeted, but rather guides action to promote community mobilisation and collaboration. The Supersetting approach is guided by the following principles: (1) integration, to ensure that activities are implemented through coordinated action across the boundaries of specific settings, (2) participation, to ensure that people are motivated to take ownership of processes of developing and implementing activities,

(3) empowerment, to ensure that people acquire skills and competencies to express and act on their visions and aspirations, (4) context-sensitivity, to ensure that everyday life challenges of citizens and professionals are acknowledged and considered when developing and implementing activities and (5) knowledge, to ensure that scientific knowledge is produced from action and used to inform action.[20]

With an emphasis on these principles, the Supersetting approach underscores its potential 'as a strategy for community-based health promotion and type 2 diabetes prevention in socially, culturally and ethnically diverse neighbourhoods'.[19] Following the Supersetting approach, HHAC addresses inequity in health by mobilising resources across local settings (kindergartens, schools and the local community arenas) and population groups (children, parents, staff and other community members) to promote social development, health and well-being.[20 30]

HHAC objectives

The overall objective of HHAC is to promote health and well-being among children aged 3–9 years living in the disadvantaged neighbourhoods of Husum and Tingbjerg in Copenhagen, Denmark.[19 20] Specific objectives are the following:

1. To promote active and healthy living among children and their parents through outdoor activities related to play, nature and cooking.
2. To build capacity and competencies of professional practitioners and families to promote sustainability of activities.
3. To develop a model of transferability of effective intervention components.

HHAC settings

Tingbjerg and Husum are neighbouring neighbourhoods located northwest of Copenhagen housing residents with ethnically and socially diverse backgrounds.[31] The area is characterised by substantial ethnic diversity, with 74.3% of residents having an immigrant background compared with 10.1% in the general Danish population.[32] This diversity contributes to a rich array of cultures, languages and traditions. The neighbourhood is also considered socially vulnerable, with lower employment rates (81.4% vs 91.4%) and educational attainment (50.1% vs 72.7%) compared with national averages.[33 34] Furthermore, the area is characterised by substantially higher prevalence rates of diabetes and other chronic diseases compared with other parts of Copenhagen.[2 35]

These demographic and health disparities underscore the relevance of the HHAC initiative, which aims to promote physical activity, food literacy and nature literacy among children and families through community-based health promotion. By addressing health behaviours early in life and strengthening local and social environments, the initiative seeks to contribute to long-term reductions in health inequalities and diabetes-related risks in disadvantaged urban communities. TCD has worked in Tingbjerg since 2015 and in Husum since 2023.

HHAC targets the following central settings in the neighbourhoods: all seven kindergartens and three primary schools, including their affiliated after-school clubs, as well as other local community settings such as the library, culture centres, green spaces, sports clubs and leisure associations.

HHAC target groups

HHAC's primary target group is all children aged 3–9 years enrolled in the involved kindergartens or primary schools. HHAC includes approximately 350 children aged 3–5 years in the kindergartens and 850 children aged 6–9 years in the primary schools. Secondary target groups include staff from the involved kindergartens and schools, as well as parents of the targeted children. In relation to staff and parents, the focus is on building capacity and competencies in play-based, nature-based and food-based activities, aiming to strengthen the implementation of activities.

HHAC partners

The HHAC partnership consists of Community Stakeholders, Activity Experts and Research Partners. A description of the partners and their roles in HHAC is shown in table 1.

The HHC governance structure

HHAC is organised around a Coordination Group of partners with a shared working space in the local community settings of Tingbjerg and Husum (figure 1). The group consists of representatives from all partner organisations except kindergartens and schools with whom the Coordination Group has meetings on an ad hoc basis. The group meets every 2 weeks to develop, discuss and evaluate initiative activities. The group also provides administrative, logistical and practical support to each other. To make room for practical and logistical planning related to activities in institutions, an Activity Group comprising the three Activity Experts and the project coordinator meets every 2 weeks to evaluate activities and safeguard their coherence and integration. The Coordination Group and Activity Group are directed by a Steering Committee comprising decision-makers from each partner organisation. A project coordinator has been appointed by Steno Diabetes Center Copenhagen (SDCC) and is responsible for coordinating activities and delegating tasks within the Coordination Group. Similarly, an evaluation coordinator from SDCC is responsible for the planning and coordination of evaluation activities within the Research Group.

The conceptual framework of HHAC

The conceptual framework of HHAC is shown in figure 2. It highlights how the initiative fosters joint action by engaging children, parents, staff and the local community in co-creating play, food and nature activities. The illustration also displays the importance of building

Table 1 The Happy Healthy Active Children partnership

Category	Partner	Description	Role in the intervention
Community Stakeholder	Kindergartens and primary schools in Husum and Tingbjerg	Seven kindergartens and three primary schools with deep knowledge of everyday life in these settings.	Ensuring communication and dialogue with children, parents and staff. Co-develop and implement activities in their own institutions, both during and after the intervention.
Community Stakeholder	Social Housing Association of Husum and Tingbjerg	Leads social development in the neighbourhoods. Long-standing experience with local engagement and project development.	Identifying and mobilising residents and other community-based stakeholders; acting as gatekeepers to community spaces.
Activity Experts	The Danish Society for Nature Conservation	NGO promoting nature and environmental protection, and public access to nature.	Co-develop and lead nature-focused activities.
Activity Experts	Gerlev Center for Play and Movement	NGO promoting play and movement culture in Denmark.	Co-develop and deliver play-based activities.
Activity Experts	Copenhagen Hospitality College	Public educational institution offering training in food and cooking. Active in Tingbjerg since 2018.	Co-develop and lead food and cooking-related activities.
Research Partner	Steno Diabetes Center Copenhagen	Research institution focused on community-based health promotion. Active in Tingbjerg since 2015.	Leading coordination and evaluation of intervention activities across themes and settings.
Research Partner	Center for Clinical Research and Prevention	Research institution specialising in preventive health research.	Leading quantitative data collection and analysis related to physical activity measurements.

NGO, non-governmental organisation.

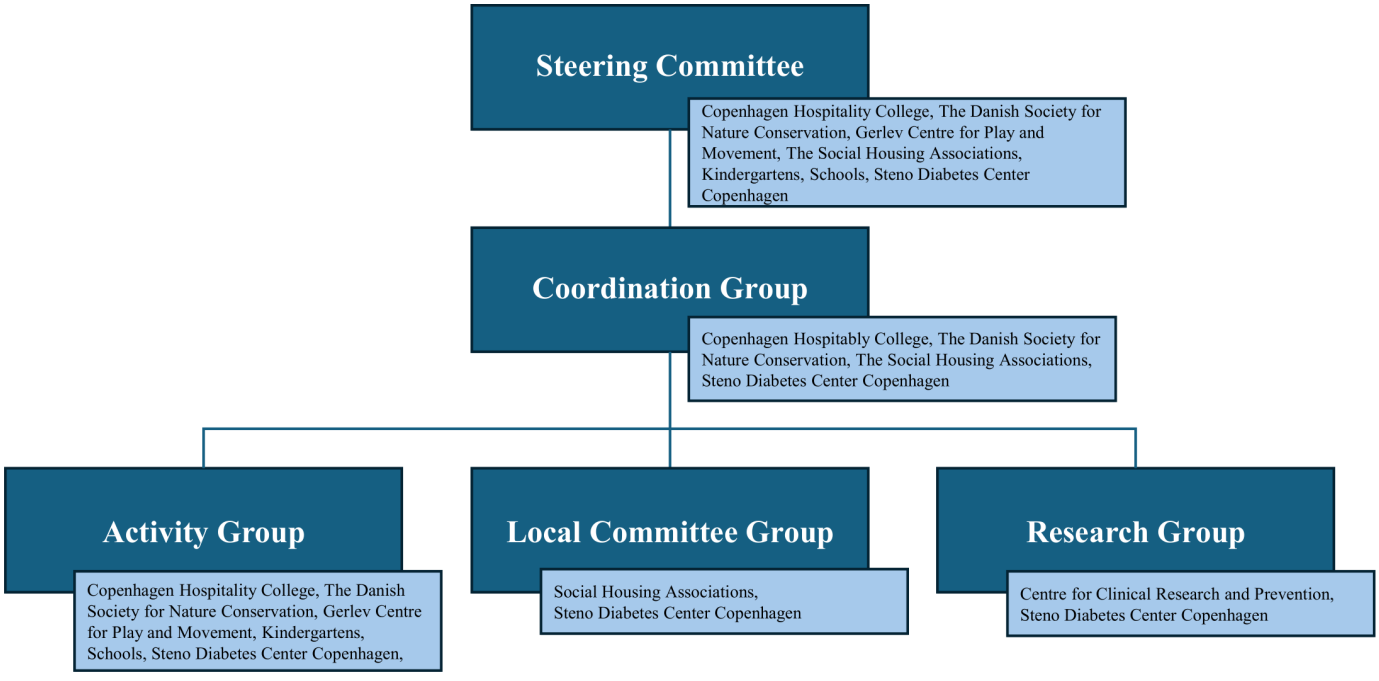

Figure 1 Organisational diagram of Happy Healthy Active Children.

Figure 2 The conceptual framework of Happy Healthy Active Children.

competencies with staff, parents and Community Stakeholders to promote sustainability of the initiative.

HHAC works with different types of activities tailored to different target groups and contexts. To ensure that partners are aligned and that activities are relevant to beneficiaries and embedded in the local contexts, all partners are involved in the co-creation of activities. This entails strong and sustained ties between partners as well as continuous involvement of potential new stakeholders in the local community.

The HHAC initiative

HHAC phases

The HHAC initiative runs from January 2023 to December 2025 (3 years) and is structured into the following three phases: (1) a 6 months preparation phase involving mobilisation and consolidation of the partnership; (2) a 24 months action phase focused on co-creating and implementing activities with children, parents and staff, while evaluating processes and outcomes; and (3) a 6 months embeddedness phase aimed at finalising activities, developing toolboxes for schools and institutions and creating a transferable model. The last phase includes a joint process with all partners to extract key learnings and translate data into recommendations that can guide the implementation of HHAC in other disadvantaged communities. The timeline of HHAC activities and assessments are illustrated in figure 3.

HHAC activities

HHAC activities address three themes—Play, Nature and Food—that are rooted in children's everyday lives in their institutions (kindergarten, schools and after-school clubs), leisure time and private homes settings.

Play

Play activities within HHAC include structured outdoor physical play activities such as non-competitive group games, fighting games and teamwork-based activities (table 2). The activities aim to stimulate physical activity, curiosity, social interaction and collaboration, while supporting motor development and well-being.[36]

Nature

Nature activities within HHAC include weekly outdoor excursions, nature walks, exploration of local flora and fauna and seasonal nature-based themes integrated into daily routines (table 2). These activities aim to strengthen children's motor skills, support mental well-being and promote environmental awareness and social skills through hands-on experiences in outdoor settings.[37–39]

Food

Food activities include outdoor cooking and shared meal preparation in informal settings such as gardens and around campfires (table 2). Children actively participate in tasting and preparing food, promoting food literacy, motor skills and sustainable habits. These activities also support social skills and cooperation, and they strengthen relationships between children, parents and staff.[29 40]

Examples of activities, their purpose, frequency and duration are presented in table 2. The three different activity themes are carried out sequentially, with each

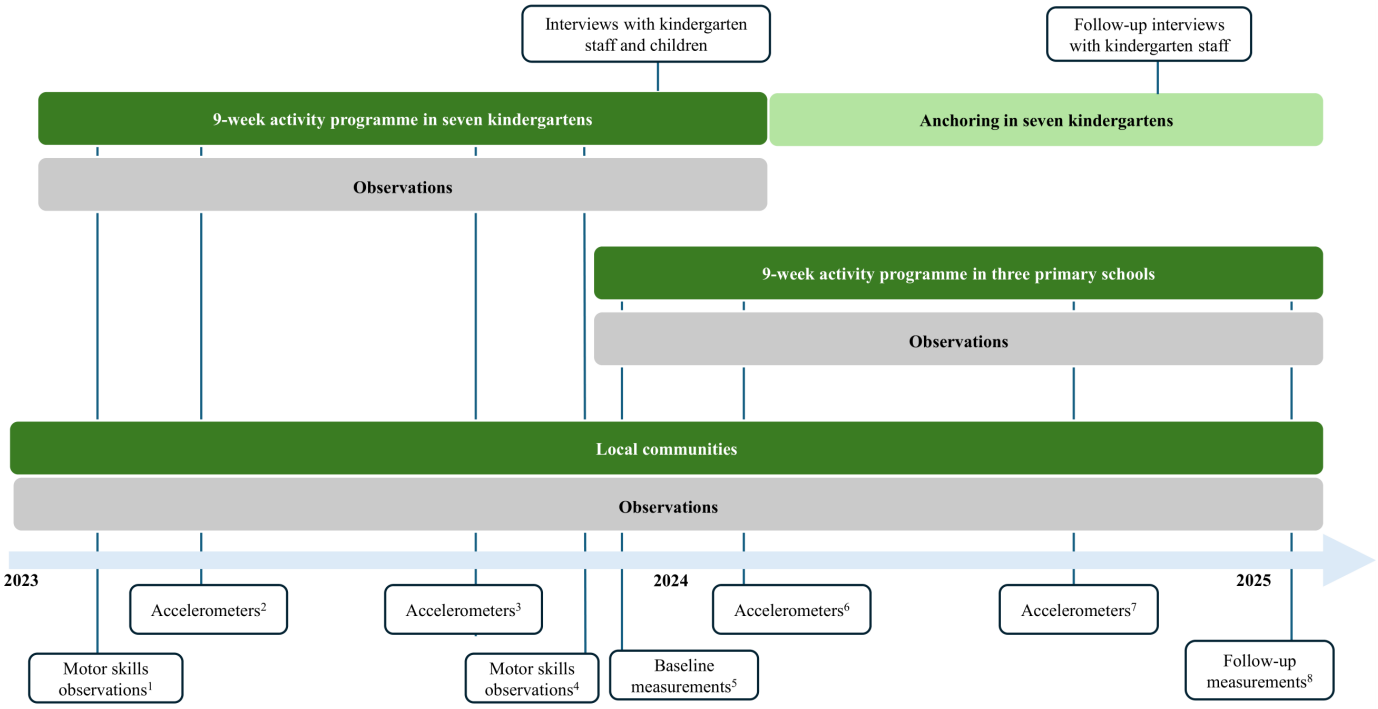

Figure 3 Timeline of enrolment initiative and assessments in Happy Healthy Active Children. [1]Observations of the participating kindergarten children's motor skills—baseline. [2]Accelerometers: Physical activity measured for 10 days—kindergarten children. [3]Accelerometers: Physical activity measured for 10 days—kindergarten children. [4]Observations of the participating kindergarten children's motor skills—follow-up. [5]Questionnaire measurement among the participating primary schoolchildren (Intervention and Control)—baseline. [6]Accelerometers: Physical activity measured for 10 days—primary schoolchildren. [7]Accelerometers: Physical activity measured for 10 days—primary schoolchildren. [8]Questionnaire measurement among the participating primary schoolchildren (Intervention and Control)—follow-up.

activity theme being introduced 1 day per week for 3 weeks in a row, followed by the next theme.

HHAC patient and public involvement

This research does not involve patients, as the study targets healthy children in kindergartens and primary schools. However, Activity Experts and Community Stakeholders are involved in the design of the activities and development of practical implementation strategies. Children, parents and Activity Experts are involved during the evaluation phase through interviews and observations to explore experiences and refine the programme theory. Dissemination activities include collaboration with local schools, kindergartens and community partners to ensure that findings are shared in accessible formats for stakeholders.

While the activity themes are predefined, the design and implementation of specific activities are developed collaboratively within the partnership and through ongoing involvement of local community stakeholders such as parents and leisure clubs. Methods and approaches are tailored to the specific contexts but include workshops with teachers, kindergarten staff, children and parents focusing on local interests and contextual attention points related to the form and content. In addition, informal and continuous dialogue and feedback with staff, parents and children guide the development of activities.

HHAC aims to ensure co-creation processes that are inclusive by creating smaller safe spaces for participation in the local communities for those who are uncomfortable with the workshop set-up. This has proven effective in engaging vulnerable population groups.[28 41–43] By also involving families in a more dynamic way—for example, gradually as they show up at activities—we aim to avoid a too uneven power distribution, which is beneficial for building engagement.[28 43 44] Co-creation takes place locally in Tingbjerg and Husum to ensure that participants feel comfortable in a familiar environment. To ensure involvement of the local families, a Parent Council is established at the beginning of the initiative. Parents are recruited through the kindergarten institutions and the Social Housing Associations, and they play a key role in engaging local families, using their local knowledge to co-create and implement activities and acting as gatekeepers to social networks that are otherwise hard to reach. Examples of activities initiated by the Parent Council include a social café at the local school that connects parents and children in social dining during and after leisure time swimming, and a parent contact person promoting participation in organised leisure activities for school children.

The co-creation processes are guided by the five core principles of the Supersetting approach[12] and operationalised by the Coordination Group. This includes

Table 2 Overview of thematic activities in Happy Healthy Active Children

Setting	Activity theme	Purpose and focus	Effects on children's development and well-being	Examples of activities	Frequency	Duration of each activity theme	Total duration of the initiative
Daycare	Play	Establish outdoor play zones and trails. Co-create activities with children. Include parents in shared play events.	Enhances motor and cognitive skills. Prevents lifestyle-related diseases. Supports overall well-being, social and environmental awareness.	Outdoor games. Group play with staff and parents. Co-designed activities. Outdoor play zones established in nearby areas. Shared play events with parents.	Weekly	3 weeks	9 weeks
Daycare	Nature	Excursions to nearby nature. Nature themes in daily routines. Pedagogical nature-based learning.	Boosts nature competencies, motor skills and health. Reduces stress and anxiety. Promotes social and environmental awareness.	Nature walks. Flora/fauna exploration. Seasonal activities. Nature themes in routines. Pedagogical outdoor learning.	Weekly	3 weeks	
Daycare	Food	Cooking in gardens or by campfire. Involve children in harvesting and preparation. Include parents in shared meals.	Encourages food courage and literacy. Enhances motor skills. Promotes sustainable food habits and relationships.	Campfire cooking. Taste games. Harvesting and meal preparation. Shared meals with parents.	Weekly	3 weeks	
School	Play	Active recess with structured play. Older pupils as play leaders. Integration of play in academic subjects.	Enhances motor and cognitive skills. Prevents lifestyle-related diseases. Strengthens well-being and connection to nature.	Active recess. Older pupils organise play patrols. Outdoor learning games (eg, math/language).	Weekly	3 weeks	9 weeks
School	Nature	Outdoor teaching. Thematic nature weeks. Connect learning to local environments.	Boosts nature competencies, motor skills and health. Reduces stress and anxiety. Promotes well-being and connection to nature.	Outdoor lessons. Nature-based projects and science teaching. Thematic weeks on biodiversity, sensory walks, etc.	Weekly	3 weeks	
School	Food	Outdoor cooking in home economics and projects. Use of school gardens and fire pits.	Encourages food courage and literacy. Enhances motor skills. Promotes sustainable food habits and relationships.	Outdoor cooking as part of school subjects. Use of school gardens. Cooking events involving pupils and parents.	Weekly	3 weeks	
Local Community	Play	Play days in parks and housing areas. Open communities focusing on movement.	Enhances motor and cognitive skills. Prevents lifestyle-related diseases. Supports social interaction and well-being.	Play events in local parks and housing areas. Movement-based open play communities for all ages.	Weekly	3 weeks	9 weeks
Local Community	Nature	Family nature activities with local actors. Activities in urban green spaces.	Boosts nature competencies, motor skills and health. Reduces stress and anxiety. Strengthens well-being and environmental engagement.	Nature walks with guides. Joint nature activities in urban green areas.	Weekly	3 weeks	
Local Community	Food	Cooking workshops and shared meals with local partners. Include community gardens.	Encourages food courage and literacy. Enhances motor skills. Promotes sustainable food habits and relationships.	Cooking workshops. Shared meals. Use of community gardens and local produce	Weekly	3 weeks	

integrating activities in the local communities (integration), creating conducive environments for participation of children, parents and families (participation), developing activities respecting people's challenges and opportunities in everyday life (context), building ownership and competencies among the target groups (empowerment) and collecting and analysing data to ensure timely knowledge and initiative progress (knowledge).

Implementation of HHAC activities in kindergartens and schools

To ensure acceptability and proper implementation of project activities, we map expectations, possibilities and resources of schools and kindergarten prior to implementation. In this process, we carry out pre-meetings with teachers and kindergarten staff, observations of the institutional contexts and continuous sparring with staff during activities. This guides the development of activities and enables experts to tailor activities to the local context. Before implementation, each activity theme (Play, Nature and Food) is introduced to staff and children, after which content and delivery is defined in collaboration between staff, children and experts. Here, the focus is on methods to facilitate outdoor play, cooking and nature activities all year round. Activity Experts prioritise collaborative activities that promote positive social interactions and inclusivity while downplaying competitive activities. Activities include playful cooking such as smashing vegetables and cooking over a bonfire, outdoor collaboration games and physical play, nature bingo and adventure runs.

Building capacity with the staff is a key objective of the initiative and therefore Activity Experts provide on-site supervision and training of staff. Procedures and actions to sustain activities are decided in collaboration with staff in each institution while ensuring easy integration into existing institutional practices. Applying an add-in approach promotes acceptability, which is central to ensuring that activities are implemented and sustained.[45] This implies promoting easily manageable and small-scale activities requiring limited resources and equipment. To ensure parental involvement, staff and experts emphasise activities that may easily be carried out at home.

Implementing activities in local community settings

Through workshops organised by Activity Experts, activities in local community settings are co-developed by the Social Housing Association, as well as families living in the neighbourhoods. Workshops take place in different local community settings such as playgrounds, libraries, community gardens and institutions and will target a broad group of families. During these activity workshops, parents and children are invited to co-develop activities that are easy to integrate in their everyday practice, for example, by testing them at home and subsequently providing feedback to Activity Experts and Research Partners. Activities may include social cooking classes, historical games and nature walks in the local community. To ensure context sensitivity and community engagement, the Parent Council plays a key role in the development of these activities in their capacity as counsellors, gatekeepers and development partners in the initiative's action phase. Local organisations and sports clubs are also invited to participate in workshops or at events and introduce their activities to the families.

Implementation of HHAC activities across settings

An important focus of HHAC is to promote integration of activities and foster synergy across settings in the local community. The Coordination Group and the Parent Council therefore work with local leisure associations to organise activities that transcend settings and expose children to diverse leisure activities. This includes inviting local leisure associations such as football clubs or scouts' associations to visit the kindergartens and schools to expose the children to their activities or involving the associations in arranging tours and events for the children. Events are carried out in the local communities throughout the programme period as a way to draw attention to the initiative, engage children and parents across settings and demarcate the beginning and end of a longer action period. Events are planned and carried out in collaboration between all partners and local families. Some of the events are distinct HHAC events, while others are wider local community events into which HHAC integrate its activities.

Implementation to ensure sustainability

HHAC is focused on creating and executing activities that remain effective and sustainable even after the project concludes. Although Activity Experts receive compensation from the project during its duration, all initiatives are primarily aimed at enhancing the capabilities of local stakeholders, including daycare and school personnel, local leisure clubs and informal networks. The project offers resources to participants, such as groceries and equipment for play and nature activities, some of which will be distributed to participants once the project is over. Additionally, all activities are crafted to be easily replicated and implemented with minimal resources and skills, thereby bolstering the sustainability of HHAC's efforts. However, we also recognise that financial considerations can influence the motivation and recruitment of certain community members, a factor that will be addressed in the model's final recommendations for transferability.

HHAC evaluation design

Realist evaluation

The HHAC evaluation applies a realist evaluation approach with a focus on what works, for whom it works and under which circumstances it works.[46] A main focus of realist evaluation is to uncover the mechanisms that lead to outcomes and explain what contextual conditions influence outcomes.[2 46] Realist evaluation also has a strong focus on process such as facilitators and barriers for implementation and how implementation influence outcomes.

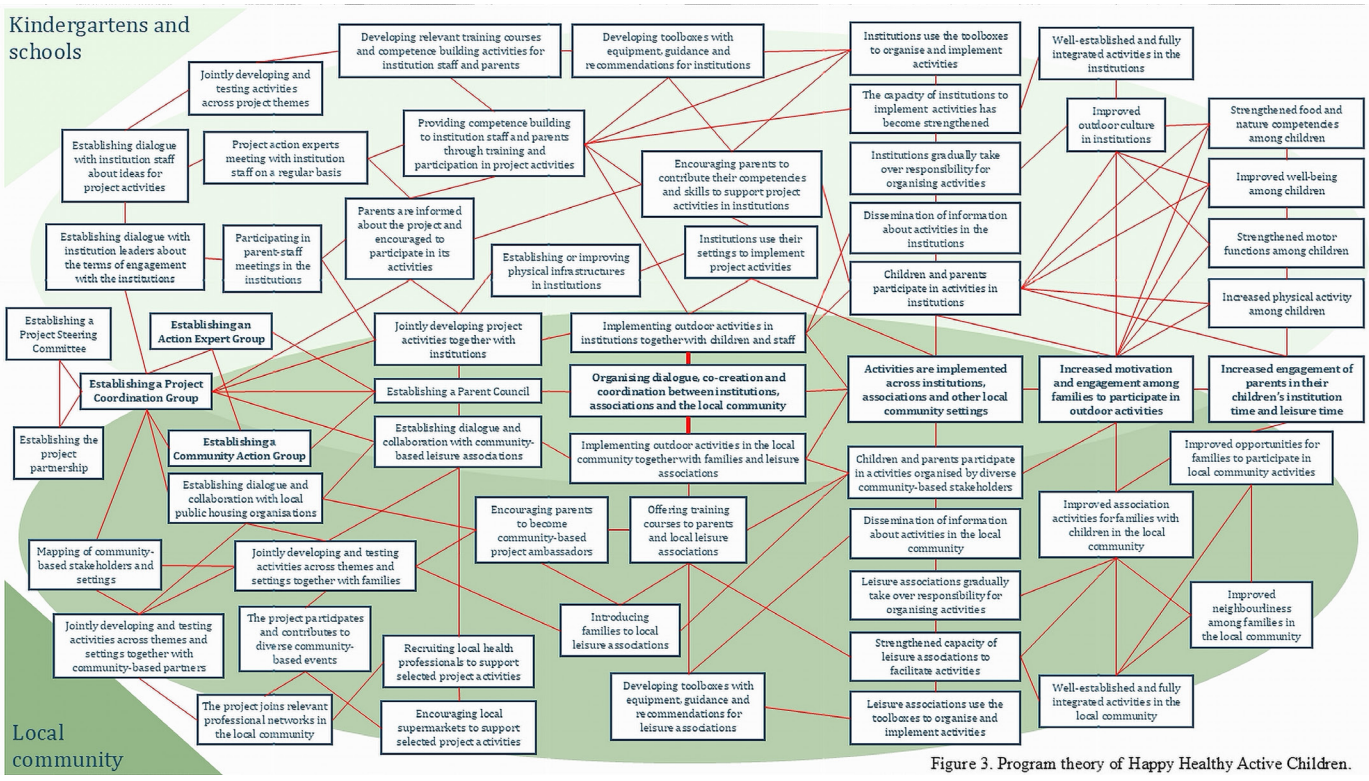

Figure 4 The programme theory of Happy Healthy Active Children.

As a theory-driven approach, realist evaluation relies on a shared understanding of how activities lead to outcomes. To support this, all HHAC partners co-develop a programme theory at the project's outset (figure 4). Subsequently, all partners jointly select prioritised context-mechanism-outcome configurations (CMOs) which are the primary focus of the evaluation. CMOs are assumptions or middle-range theories about mechanisms that are activated by the initiative in different contexts eventually leading to the intended (or unintended) outcomes.[46] The selected CMO's focus on (1) capacity building with kindergartens and schools, (2) intersectoral engagement and collaboration between all involved stakeholders in the local community, (3) parental engagement in children's leisure activities and (4) intervention outcomes related to children. The programme theory and CMO's are pivotal in defining the initiative and evaluation focus points.

The realist evaluation of HHAC is divided into a qualitative component focusing on processes, contexts, mechanisms and experienced outcomes and a quantitative component focusing on effects of activities on children's physical activity, motor skills, food literacy, nature literacy and well-being.

To ensure regular feedback, emergent learning and adjustment, evaluators among the Research Partners are involved in the planning and development of the initiative activities.[47–50] Evaluators thus take part in meetings with both the Activity Experts and the Coordination Group, which ensures continuous knowledge sharing and timely reporting.

HHAC qualitative processes and outcomes evaluation

A comprehensive qualitative process and outcomes evaluation examines the implementation, acceptability, perceptions and contextual factors and mechanisms shaping outcomes defined in the before-mentioned CMOs.

The specific focus areas are determined jointly by the Coordination Group and the Research Partners. Evaluation and initiative development are intertwined and closely connected to the programme theory, which is tested and adjusted continuously throughout the intervention period in feedback loops. This ensures timely feedback on initiative activities whereby the initiative can be adjusted. These learnings will be applicable in a model for transferability.

Process and outcome data includes qualitative interviews with staff, children, parents, Activity Experts and representatives from local leisure organisations. Field observations during activities are conducted by the Research Partners and activity logs are made by the Activity Experts. Data is transcribed ad verbatim and subsequently coded in NVivo V.14 using thematic analysis based on CMOs.[51] To ensure continuous learning, data will not only be collected and presented after the intervention, but continuously after each activity period.

HHAC effectiveness evaluation

Data on effectiveness is used to document if the initiative in kindergartens and schools has an impact on children's physical activity levels, motor skills, food literacy, nature literacy and well-being. Data is collected at two time points: at baseline before initiation of activities

(baseline assessment), and immediately after the activity periods (follow-up assessment). The primary outcome measure is differences in physical activity levels on days with HHAC activities compared with regular days in kindergartens and schools. Secondary outcome measures are food literacy, nature-based literacy and well-being of the schoolchildren who have participated in HHAC activities in the participating schools compared with peers in the control classes. The effectiveness evaluation includes three comparable control schools based on socioeconomic and ethnic composition.[52] Questionnaire data is not collected at kindergarten level due to the children's ages. The following outcome measurements are included in the effectiveness evaluation.

Physical activity is measured using Axivity AX3 accelerometers (Axivity, Newcastle, UK) in a within-subject design to investigate whether, and to what extent, children's physical activity levels differ on days with HHAC activities compared to regular days. This is carried out in both kindergartens and schools. Children in all age groups are asked to wear an accelerometer for 10 consecutive days two times during the activity period.

Food literacy, nature literacy and well-being measurements are conducted using an online questionnaire. Children aged 8–9 (second and third grade) are asked to fill out an audio-assisted questionnaire during school hours using school laptops. Questionnaires are distributed through the digital platform Klassetrivsel.dk. Younger children in kindergarten will not be asked to fill out questionnaires as most of the questions have not been validated for that age group. The questionnaire contains questions that measure food literacy (Food Literacy Questionnaire for Schoolchildren, FL-sc)[53 54] and self-reported well-being and quality of life (KIDSCREEN-27).[55] The FL-sc questionnaire has been adapted to fit the needs of the children of interest in HHAC. The nature-based literacy questionnaire is developed specifically for the HHAC initiative and the methodology for its development and validation is currently in the process of being published. The process is inspired by recent guidelines by Boateng *et al*.[56]

The evaluation is conducted using a quasi-experimental design with classes receiving the HHAC initiative and control classes. The control schools are carefully chosen to match the HHAC initiative schools in terms of ethnicity and socioeconomic reference.[57] Two of the control schools are located in the southern part of Copenhagen Municipality to ensure that the participating classes are not influenced by the HHAC initiative. The third control school is located in Odense Municipality. Each control class receives 1000 Danish kroner (equivalent to €130) as a token of appreciation for their participation. The children in the control classes provide consent in the same way as the children in the classes participating in the HHAC initiative.

Parental consent for the participating children is obtained through a two-step process. First, via AULA, which is a digital communication platform for parents, teachers and children in Danish schools and kindergartens. Here, parents receive information about the project and are given the opportunity to provide consent. Second, parents who do not respond via AULA will be contacted by the class coordinator to obtain consent.

Questions about personal characteristics of involved schoolchildren are integrated into the parental consent form and include the following variables: biological gender, age, socioeconomic status (SES), age, birth country, family structure, number of siblings living at home and main language spoken at home. Age is measured based on the child's year and day of birth. SES is based on questions about parental educational level and occupational status.

Motor skills of children are measured in kindergartens before and after an activity period using an observational checklist with exercises chosen for HHAC. The motor skills observations are based on material developed by the Municipality of Copenhagen as part of the 'Children and Movement Culture' (BOB) initiative.[58] The exercises focus particularly on the proprioceptive sense (lying on the stomach, throwing/catching, lifting/carrying), the tactile sense (rolling, playing with various materials) and the vestibular sense (balance, swinging, somersaults). Children are asked to perform the exercises while trained staff observe and record their individual performances based on predefined scoring template. The participating schools have chosen not to focus on motor skill development, and consequently, this component of the initiative is not included for school children.

HHAC model for transferability: One of the objectives of HHAC is to develop a model of transferability of initiatives components (objective three). This is done by ensuring solid contextual data and learnings from actions in the different settings throughout all phases of the initiative. The realist evaluation contributes knowledge related to implementation processes and outcomes while systematic logs of project development and decisions will contribute knowledge on internal organisational structures, which is central in terms of understanding the potential of transferring initiative components to other settings. In the final phase of the project, qualitative data (ie, interviews with children, parents, staff and partners) is coded and analysed to extract central learnings related to the implementation and anchoring of play-based, nature-based and food-based activities in kindergartens, schools and other local community settings in the two neighbourhoods. This is complemented by specific case descriptions. Data analysis will be triangulated by initially involving several project employees in the process of analysing data followed by joint analysis workshops involving both Research Partners and praxis partners. Using the principles of design thinking, analysis workshops will be followed by ideating workshops where insights will be translated into concrete recommendations and step-by-step guides on how to implement HHAC activities in similar public housing areas. A prototype model containing a step-by-step implementation guideline and

recommendations for actions will be tested with relevant stakeholders in diverse municipalities and public housing areas in Denmark prior to national scaling.

Data analysis plan

Data from HHAC is analysed separately for kindergartens and schools due to differences in study design. To investigate the impact of activities in kindergartens on the children's physical activity levels, a within-subject design comparing physical activity levels on days with HHAC activities to regular kindergarten days is applied. In schools, the impact on the activities on the schoolchildren's food literacy, nature-based literacy and well-being is investigated using a quasi-experimental design with a matched control group.

Primary outcome: physical activity

Accelerometer data from the Axivity AX3 devices are processed to determine daily time spent per day in each of the three physical activity intensity levels: sedentary, light and moderate-to-vigorous physical activity. The validity and reliability of the AX3 accelerometers have previously been described.[59]

In both kindergartens and schools, physical activity levels are compared within subjects across HHAC activity days and regular days using paired t-tests or linear mixed models, accounting for repeated measures. Covariates such as age, gender and SES are included in adjusted models.

Secondary outcomes: food literacy, nature-based literacy and well-being

Data from the school-based questionnaires are analysed to assess group-level changes over time and between intervention and control classes. Descriptive statistics summarise baseline characteristics. For normally distributed data, linear mixed models are used to analyse changes over time and between groups. For non-normally distributed data, generalised linear models or non-parametric tests (eg, Wilcoxon rank-sum) are applied, as appropriate. All models account for clustering at class level and are adjusted for relevant covariates.

Nature-based literacy is assessed using a newly developed questionnaire. The development and validation of this instrument for measuring nature literacy in primary schoolchildren, including a pragmatic psychometric approach and exploratory factor analysis, will be described elsewhere.

Motor skills (kindergarten)

Changes in observed motor skills are analysed using descriptive statistics and paired t-tests or Wilcoxon signed-rank tests, depending on data distribution. Observational ratings before and after the HHAC activity period are compared at the individual level.

Patterns of missing data are to be explored and reported. If appropriate, multiple imputation techniques are used to address missing values, particularly in questionnaire data.

Quantitative analyses are conducted using statistical software (R and Stata V.18). For linear models, the *lmerTest* package is used in R to provide p values for fixed effects in mixed models.[60] All tests are two-tailed and a p value of <0.05 are considered statistically significant.

Power calculation and sample size

In total, the evaluation is expected to include approximately 850 children from primary schools (aged 6–9 years) and 350 children from kindergarten institutions (aged 3–5 years).

The sample size was calculated to detect a moderate effect size (Cohen's d=0.50) in the primary outcomes, with a statistical power of 80% and a two-sided significance level of 0.05. Based on these assumptions, a minimum of 64 participants per group is required to detect statistically significant differences. This effect size corresponds with those commonly reported in similar initiatives addressing physical activity and related health behaviours among children enrolled in kindergartens and primary schools.[61]

To account for the clustered nature of data, an intracluster correlation coefficient of 0.05 was applied, in line with estimates from comparable initiatives.[62 63] Adjusting for the design effect due to clustering increases the required sample size to approximately 100 participants per group.

This adjusted sample size ensures adequate statistical power to detect meaningful effects of the intervention across primary outcomes, while accounting for both clustering and potential attrition.

HHAC data security and ethics

All collected data is handled and stored in compliance with the European Union General Data Protection Regulation and the Danish National Data Protection legislation. The data collection is registered in the local records of data processing activities at the Capital Region of Denmark (journal no.: p-2023-14277). Qualitative interviews with parents, children and staff will be anonymised; however, the identities of partner institutions and collaborating organisations are disclosed. Quantitative data collected via external platforms or devices are securely stored on restricted-access drives belonging to the Research Partners under approved data processing agreements. Access to all data is restricted to research personnel working with data management and analysis.

All legal guardians of children participating in the HHAC initiative must provide written informed consent in their native language prior to enrolment of children in activities. Detailed information about HHAC is provided to the legal guardians and children, with all information communicated in a language and at a level appropriate for their age and understanding. Care is taken to ensure that all communication is non-stigmatising for both children and families. Data is used for scientific dissemination and for model development and stored securely by Research Partners.

DISCUSSION

HHAC addresses inequity in health by targeting two disadvantaged neighbourhoods and working with structured change processes in kindergartens, schools and local community-based settings. It stands out by operating with the Supersetting approach aiming to integrate change across settings and by connecting settings and resources already present and available in the neighbourhoods.[20] This is an approach that, to our knowledge, is still quite novel. While more recent literature acknowledges the need for larger, more complex multilevel interventions, newer research also suggests that such approaches are still less widespread than more traditional single components behavioural initiatives, and those that exist seldom document their impact.[64] The reason may be that they are perceived as time-consuming, hard to navigate and costly, and that traditional evaluation approaches may not be adequate.[20 23 65 66] This paper has presented HHAC as a potential approach to addressing inequity in health in disadvantaged settings.

Strengths and limitations

A key strength of the HHAC initiative lies in its well-described conceptual framework to health promotion in disadvantaged neighbourhoods, namely the Supersetting approach. By working across sectors and settings, the initiative enhances ecological validity and reflects real-world complexity, for example, by working with approaches that target both the institutional context and more vulnerable families in local community settings. We know that recruitment and retainment of vulnerable population groups presents a major challenge in health promotion. For the same reason, both activity development and evaluation pay special attention to participation practices by integrating contextual, explorative investigations of barriers and facilitators for participation. This provides us with important knowledge about how to carry out HHAC activities that feel safe, meaningful and motivating. Importantly, the integration of a realist evaluation methodology enhances the initiative's ability to adapt dynamically to emerging insights and contextual realities.[46 67] By systematically exploring what works, for whom and under what circumstances, the HHAC initiative offers valuable insights into how participatory approaches can be tailored to vulnerable population groups in disadvantaged settings. This iterative approach is essential for balancing the fidelity and flexibility needed in complex community-based health promotion.[24]

Nonetheless, the study also has limitations. First, its implementation in only two neighbourhoods within a Danish context may limit generalisability of findings to other public housing areas. Second, the complex and adaptive nature of the initiative makes it challenging to attribute outcomes to specific components or mechanisms—a common limitation in complex systems research.[24 66] Third, recruitment and sustained engagement of vulnerable families remain difficult, and participation may vary across settings and over time despite targeted efforts to ensure inclusiveness.[44]

Finally, although the quasi-experimental design with matched control groups increases robustness, the lack of full randomisation introduces potential biases. However, the realist evaluation methodology helps mitigate the risk of bias by contextualising findings and elucidating causal pathways within specific environments.[46]

Author affiliations
[1]Steno Diabetes Center Copenhagen, Department of Prevention Health Promotion and Community Care, Herlev, Capital Region of Denmark, Denmark
[2]Center for Clinical Research and Prevention, Bispebjerg and Frederiksberg Hospital, Frederiksberg, Capital Region of Denmark, Denmark

Acknowledgements We sincerely thank the participating staff in kindergartens and schools, as well as involved children and their parents, for their cooperation, time, efforts and support.

Contributors Guarantor: PB. Conceptualisation: PB. Design: TT, MS, NSW, AB, NV, NF, ALM, PE, PB. Methodology: TT, MS, NSW, ALM, PE, PB. Data collection: TT, MS, NF, ALM. Qualitative data cleaning and analysis: TT, NF. Quantitative data cleaning and analysis: MS, ALM, PE. Project coordination: AB, NV. Writing—original draft: TT, MS. TT and MS contributed equally to this paper. Writing—review and editing: TT, MS, NF, ALM, PE, NSW, AB, NV, SBM, PB. Project administration and funding acquisition: PB. All authors have read and approved the final manuscript. Declaration of AI Use The authors used ChatGPT 4.0 in parts of the manuscript for language editing, including proofreading and minor text reduction, to improve readability and language of the manuscript. The content was subsequently reviewed and edited by the authors, who take full responsibility for the final publication.

Funding The HHAC initiative receives funding from Novo Nordisk Foundation (www.novonodriskfonden.dk) by grant no. NNF22SH0077048 in the call "Children, Health and Movement 2022" awarded to PB (principal investigator). The Novo Nordisk Foundation has no role in designing the project nor in developing or submitting the protocol for publication. Moreover, the foundation has no role in data collection, data analysis, interpretation of results or in any decision to submit future publications.

Competing interests None declared.

Patient and public involvement Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

Patient consent for publication Consent obtained from parent(s)/guardian(s).

Provenance and peer review Not commissioned; externally peer reviewed.

ORCID iDs
Maria Stougaard https://orcid.org/0000-0002-5573-4971
Nanna Wurr Stjernqvist https://orcid.org/0009-0002-3854-3329

REFERENCES

1 WHO, 'World Health Organization. Noncommunicable diseases: childhood overweight and obesity. Geneva' WHO; 2020. Available: https://www.who.int/news-room/questions-and-answers/item/noncommunicable-diseases-childhood-overweight-and-obesity
2 Jensen H, *et al*. Danskernes sundhed 2021: den nationale sundhedsprofil 2021. 2022.
3 Wyszyńska J, Ring-Dimitriou S, Thivel D, *et al*. Physical Activity in the Prevention of Childhood Obesity: The Position of the European Childhood Obesity Group and the European Academy of Pediatrics. *Front Pediatr* 2020;8:535705.

4 Chen J, Song W, Zhao X, *et al*. The relationship between fundamental motor skills and physical fitness in preschoolers: a short-term longitudinal study. *Front Psychol* 2023;14:1270888.
5 Rasmussen M, Kierkegaard L, Rosenwein S, *et al*. Health behaviour in school aged children. Statens Institut for Folkesundhed; 2019.
6 Griffiths LJ, Parsons TJ, Hill AJ. Self-esteem and quality of life in obese children and adolescents: A systematic review. *Int J Pediatr Obes* 2010;5:282–304.
7 Buttitta M, Iliescu C, Rousseau A, *et al*. Quality of life in overweight and obese children and adolescents: a literature review. *Qual Life Res* 2014;23:1117–39.
8 Pont SJ, Puhl R, Cook SR, *et al*. Stigma Experienced by Children and Adolescents With Obesity. *Pediatrics* 2017;140:e20173034.
9 Holstein BE. Mental sundhed og psykisk sygdom hos 0-9-årige børn, 1. udgave. Kbh.: Vidensråd for Forebyggelse; 2021.
10 Algren MH, Ekholm O, Nielsen L, *et al*. Social isolation, loneliness, socioeconomic status, and health-risk behaviour in deprived neighbourhoods in Denmark: A cross-sectional study. *SSM Popul Health* 2020;10:100546.
11 Holstein BE, Damsgaard MT, Pedersen TP, *et al*. Persistent Social Inequality in Adolescent Health Indicators 1991–2022: Trend Study From Denmark. *Int J Public Health* 2024;69:1607698.
12 Fernandez-Gavira J, Huete-Garcia A, Velez-Colon L. Vulnerable groups at risk for sport and social exclusiond. *JPES* 2017;17:312–26.
13 Fraguela Vale R, De-Juanas Oliva Á, Franco Lima R. Ocio deportivo en jóvenes potencialmente vulnerables: beneficios percibidos y organización de la práctica. *Ped Soc Rev Int* 2018;31:49.
14 Badura P, Hamrik Z, Dierckens M, *et al*. After the bell: adolescents' organised leisure-time activities and well-being in the context of social and socioeconomic inequalities. *J Epidemiol Community Health* 2021;75:628–36.
15 Opačić A. Effects of living in disadvantaged neighbourhoods on personal well-being. In: Opačić A, ed. *Practicing social work in deprived communities*. Cham: Springer International Publishing, 2021: 37–67.
16 Pysmenna O, Anderson KM. Income and Health Perceptions in an Economically Disadvantaged Community: A Qualitative Case Study from Central Florida. *Int Journal of Com WB* 2022;5:687–710.
17 Ewart-Pierce E, Mejía Ruiz MJ, Gittelsohn J. "Whole-of-Community" Obesity Prevention: A Review of Challenges and Opportunities in Multilevel, Multicomponent Interventions. *Curr Obes Rep* 2016;5:361–74.
18 Greenhalgh T, Jackson C, Shaw S, *et al*. Achieving Research Impact Through Co-creation in Community-Based Health Services: Literature Review and Case Study. *Milbank Q* 2016;94:392–429.
19 Tørslev MK, Andersen PT, Nielsen AV, *et al*. Tingbjerg Changing Diabetes: a protocol for a long-term Supersetting initiative to promote health and prevent type 2 diabetes among people living in an ethnically and socioeconomically diverse neighbourhood in Copenhagen, Denmark. *BMJ Open* 2021;11:e048846.
20 Bloch P, Toft U, Reinbach HC, *et al*. Revitalizing the setting approach – supersettings for sustainable impact in community health promotion. *Int J Behav Nutr Phys Act* 2014;11:118.
21 Carlisle S. Tackling health inequalities and social exclusion through partnership and community engagement? A reality check for policy and practice aspirations from a Social Inclusion Partnership in Scotland. *Crit Public Health* 2010;20:117–27.
22 Henderson S, Wagner JL, Gosdin MM, *et al*. Complexity in partnerships: A qualitative examination of collaborative depression care in primary care clinics and community-based organisations in California, United States. *Health Soc Care Community* 2020;28:1199–208.
23 Termansen T, Bloch P, Tørslev MK, *et al*. Tingbjerg Changing Diabetes: experiencing and navigating complexity in a community-based health promotion initiative in a disadvantaged neighbourhood in Copenhagen, Denmark. *BMC Public Health* 2023;23:392.
24 Moore GF, Evans RE, Hawkins J, *et al*. From complex social interventions to interventions in complex social systems: Future directions and unresolved questions for intervention development and evaluation. *Evaluation (Lond)* 2019;25:23–45.
25 Hernández ED, Cobo EA, Cahalin LP, *et al*. Impact of structural-level environmental interventions on physical activity: a systematic review. *Int Arch Occup Environ Health* 2023;96:815–38.
26 Bruun JM. Forebyggelse af overvægt blandt børn og unge, 1. udgave. Kbh.: Vidensråd for Forebyggelse; 2021.
27 Hochgerner J. Empowerment, co-creation and social innovation ecosystems. In: *Atlas of social innovation: new practices for a better future*. 2018: 219–22.
28 Termansen T, Bloch P, Tørslev MK, *et al*. Spaces of participation: Exploring the characteristics of conducive environments for citizen participation in a community-based health promotion initiative in a disadvantaged neighborhood. *Health Place* 2023;80:102996.
29 Tørslev MK, Bjarup Thøgersen D, Høstgaard Bonde A, *et al*. Supporting Positive Parenting and Promoting Healthy Living through Family Cooking Classes. *Int J Environ Res Public Health* 2021;18:4709.
30 Aagaard-Hansen J, Bloch P. Settings, populations, and time: a conceptual framework for public health interventions. *Front Public Health* 2023;11:1297019.
31 Ministry of the Interior and Building and Housing. Liste over udsatte boligområder pr. 1. Ministry of the Interior and Building and Housing; 2021.
32 Norredam M, Kastrup M, Helweg-Larsen K. Register-based studies on migration, ethnicity, and health. *Scand J Public Health* 2011;39:201–5.
33 Petersson F, Baadsgaard M, Thygesen LC. Danish registers on personal labour market affiliation. *Scand J Public Health* 2011;39:95–8.
34 Jensen VM, Rasmussen AW. Danish Education Registers. *Scand J Public Health* 2011;39:91–4.
35 Landsbyggefonden. Strategisk samarbejdsaftale om boligsocial indsats. Landsbyggefonden; 2020. Available: https://www.kk.dk/sites/default/files/agenda/01f2d226-caf9-4fc3-9543-0fec926bf532/d8e43ee5-a032-4a03-8ba6-d73a3d1a7e37-bilag-2.pdf
36 Zosh JM, Hirsh-Pasek K, Hopkins EJ, *et al*. Accessing the Inaccessible: Redefining Play as a Spectrum. *Front Psychol* 2018;9:1124.
37 Chawla L. Benefits of Nature Contact for Children. *J Plan Lit* 2015;30:433–52.
38 Gray C, Gibbons R, Larouche R, *et al*. What Is the Relationship between Outdoor Time and Physical Activity, Sedentary Behaviour, and Physical Fitness in Children? A Systematic Review. *IJERPH* 2015;12:6455–74.
39 Fjørtoft I. The Natural Environment as a Playground for Children: The Impact of Outdoor Play Activities in Pre-Primary School Children. *Early Child Educ J* 2001;29:111–7.
40 Allirot X, da Quinta N, Chokupermal K, *et al*. Involving children in cooking activities: A potential strategy for directing food choices toward novel foods containing vegetables. *Appetite* 2016;103:275–85.
41 Cornwall A. Making spaces, changing places: situating participation in development. in ids working paper, no. 170. Brighton: Institute of Development Studies; 2002.170.
42 Breuer D. *Community participation in local health and sustainable development: approaches and techniques /[text editing: David breuer*. Copenhagen: World Health Organization, Regional Office for Europe, 2003.
43 Kamruzzaman P. Exploring the Nexus Between Participation and Empowerment. *JDPP* 2020;5:32–53.
44 Knibbe M, Horstman K. The making of new care spaces. How micropublic places mediate inclusion and exclusion in a Dutch city. *Health Place* 2019;57:27–34.
45 Bentsen P, Bonde AH, Schneller MB, *et al*. Danish "add-in" school-based health promotion: integrating health in curriculum time. *Health Promot Int* 2020;35:e70–7.
46 Pawson R, Tilley N. *Realistic evaluation, reprinted*. London: SAGE, 2010.
47 Lissack MR. Complexity: the Science, its Vocabulary, and its Relation to Organizations. *Emergence* 1999;1:110–26.
48 Phelps R, Hase S. Complexity and action research: exploring the theoretical and methodological connections. *Educ. Action Res.* 2002;10:507–24.
49 Heron J, Reason P. The practise of co-operative inquiry: research "with" rather than "on" people. In: *Handbook of action research*. 1. London: Sage, 2001.
50 Olesen BR, Nordentoft HM. Walking the Talk? A Micro-Sociological Approach to the Co-Production of Knowledge and Power in Action Research. *IJAR* 2013;9:67–94.
51 Braun V, Clarke V. What can "thematic analysis" offer health and wellbeing researchers? *Int J Qual Stud Health Well-being* 2014;9:26152.
52 Danish Ministry for Children and Education. Danish ministry for children and education, 'Metodenotat: bag om de socioøkonomiske referencer for grundskolekarakterer. Danish Ministry for Children and Education; 2021. Available: https://uddannelsesstatistik.dk/Pages/Topics/13.aspx
53 Benn J. Food, nutrition or cooking literacy—a review of concepts and competencies regarding food education. *IJHE* 2014;7.
54 Stjernqvist NW, Elsborg P, Ljungmann CK, *et al*. Development and validation of a food literacy instrument for school children in a Danish context. *Appetite* 2021;156.

55 Ravens-Sieberer U, Erhart M, Rajmil L, *et al*. Reliability, construct and criterion validity of the KIDSCREEN-10 score: a short measure for children and adolescents' well-being and health-related quality of life. *Qual Life Res* 2010;19:1487–500.
56 Boateng GO, Neilands TB, Frongillo EA, *et al*. Best Practices for Developing and Validating Scales for Health, Social, and Behavioral Research: A Primer. *Front Public Health* 2018;6:149.
57 Danish Ministry for Children and Education. 'Metodenotat: bag om de socioøkonomiske referencer for grundskolekarakterer. 2025. Available: https://uddannelsesstatistik.dk/Pages/Topics/13.aspx
58 Municipality of Copenhagen. 'Børn og bevægelseskultur. 2023. Available: https://bedstsammen.kk.dk/sites/default/files/2023-08/Kompendium%20-%20BOB-del-1.pdf
59 Hedayatrad L, Stewart T, Duncan S. Concurrent Validity of ActiGraph GT3X+ and Axivity AX3 Accelerometers for Estimating Physical Activity and Sedentary Behavior. *J Meas Phys Behav* 2021;4:1–8.
60 Kuznetsova A, Brockhoff PB, Christensen RHB. **lmerTest** Package: Tests in Linear Mixed Effects Models . *J Stat Soft* 2017;82:13.
61 Pate RR, O'Neill JR, Brown WH, *et al*. Prevalence of Compliance with a New Physical Activity Guideline for Preschool-Age Children. *Child Obes* 2015;11:415–20.
62 Tarp J, Domazet SL, Froberg K, *et al*. Effectiveness of a School-Based Physical Activity Intervention on Cognitive Performance in Danish Adolescents: LCoMotion-Learning, Cognition and Motion - A Cluster Randomized Controlled Trial. *PLoS One* 2016;11:e0158087.
63 Ridgers ND, Fairclough SJ, Stratton G. Variables associated with children's physical activity levels during recess: the A-CLASS project. *Int J Behav Nutr Phys Act* 2010;7:74.
64 Nickel S, von dem Knesebeck O. Do multiple community-based interventions on health promotion tackle health inequalities? *Int J Equity Health* 2020;19:157.
65 Auspos P, Cabaj M. Complexity and community change: managing adaptively to improve effectiveness. Aspen Institute; 2014.
66 Braithwaite J, Churruca K, Long JC, *et al*. When complexity science meets implementation science: a theoretical and empirical analysis of systems change. *BMC Med* 2018;16:63.
67 Salter KL, Kothari A. Using realist evaluation to open the black box of knowledge translation: a state-of-the-art review. *Implementation Sci* 2014;9:115.