

# Striving for a systems approach in childhood obesity prevention

A White Paper based on the GrowH! project

June 2024

The GrowH! project was funded by the Joint Programming Initiative “A Healthy Diet for a Healthy Life” (JPI HDHL), a research and innovation initiative of EU member states and associated countries.

## Authors

**Stefaan De Henauw**, Ghent University, Faculty of Medicine, Department of Public Health and Primary Care, Belgium

**Teatske Altenburg**, VU University Medical Center (VUMC) Amsterdam Public Health Research Institute, Netherlands

**Alejandra Sotomayor Sainz**, Ghent University, Faculty of Medicine, Department of Public Health and Primary Care, Belgium

**Laura Belmon**, VU University Medical Center (VUMC) Amsterdam Public Health Research Institute, Netherlands

**Claudia Börnhorst**, Leibniz Institute for Prevention Research and Epidemiology – BIPS, Department of Biometry and Data Management, Germany

**Tilman Brand**, Leibniz Institute for Prevention Research and Epidemiology – BIPS, Department of Prevention and Evaluation, Germany

**Luis A. Moreno**, University of Zaragoza, Faculty of Health Science, Spain

**Stefanie Vandevijvere**, Sciensano, Directorate Epidemiology and Public Health, Belgium

**Wolfgang Ahrens**, Leibniz Institute for Prevention Research and Epidemiology – BIPS, Department of Epidemiological Methods and Etiological Research, Germany

on behalf of the GrowH! consortium.

## Contributors

With thanks to the GrowH! Systems Science Advisory Board for their contribution to the GrowH! Project and this document:

**Steven Allender**, Deakin University, Faculty of Health, School of Health and Social Development, Global Obesity Centre, Australia

**Loretta Sollars**, Public Health England, Department of Health and Social Care, United Kingdom

**Karien Stronks**, Amsterdam University Medical Centers, Department of Public Health, Netherlands

**Catherine Woods**, University of Limerick, Faculty of Education and Health Sciences, Department of Physical Education and Sport Sciences, Ireland

Obesity prevention tailored to critical transition periods  
in the early life-course - GrowH!

<https://www.growth.eu>

Contact: [growth@leibniz-bips.de](mailto:growth@leibniz-bips.de)

## The GrowH! Consortium

### Partner institutes

<b>Institute</b>	<b>Members</b>
Leibniz Institute for Prevention Research and Epidemiology – BIPS (BIPS) Germany	Wolfgang Ahrens (Project coordinator) Ina Alvarez Franco Claudia Börnhorst Tilman Brand Christoph Buck Heide Busse Antje Hebestreit Iris Pigeot Stefan Rach Marie Lisanne Schepan Maike Wolters Hajo Zeeb
Amsterdam University Medical Center, Department of Social Medicine (AMC) Netherlands	Tanja Vrijkotte (Principal Investigator)
Ghent University, Faculty of Medicine, Department of Public Health (UGENT) Belgium	Stefaan De Henauw (Principal Investigator) Alejandra Sotomayor Sainz
Landesvereinigung für Gesundheit Bremen e.V. (State Association for Health) (LVG) Germany	Thomas Altgeld (Principal Investigator) Elisabeth Rataj
University of Zaragoza, Faculty of Health Science (UNIZAR) Spain	Luis Moreno (Principal Investigator) Maria del Pilar de Miguel-Etayo
VU University Medical Center (VUMC) Amsterdam, Public Health Research Institute, Department Public and Occupational Health Netherlands	Teaske Altenburg (Principal Investigator) Laura Belmon

### Project collaborators

<b>Institute</b>	<b>Members</b>
Sciensano, Directorate Epidemiology and Public Health (SCIENSANO) Belgium	Stefanie Vandevijvere
University of Guelph, Department of Family Relations and Applied Nutrition (GUELPH) Canada	Jess Haines

## Table of Content

### **Preface : Rationale, history and finality of the GrowH! White Paper**

<b>Chapter 1. Problem statement – childhood obesity as a complex problem</b>	<b>7</b>
1.1 Childhood obesity in Europe	7
1.2 Childhood obesity as a complex systems problem	7
1.3 Whole systems approaches to childhood obesity prevention	13
1.4 Adopting a system’s lens in behaviour oriented intervention programmes	16
<b>Chapter 2. Building blocks for the implementation of a systems approach to childhood obesity prevention</b>	<b>22</b>
2.1 Establishing building blocks for the implementation of a systems approach in childhood obesity prevention	22
2.2 Building a community partnership	22
2.3 Equity and inclusiveness	24
2.4 Supporting political environment	25
2.5 Understanding the local obesogenic system	26
2.6 Adaptive action development, implementation and evaluation	27
2.7 Systematic program coordination	29
2.8 Underpin the approach with theory and evidence	31
Conclusion	31
<b>Chapter 3. How to address the obesogenic environment in childhood obesity prevention: key learnings from the GrowH! project</b>	<b>33</b>
A1 Introduction	37
A2 Hypothetical interventions: what, why and how?	37
A2.1 Key results	38
A2.2 Interpreting the findings from a systems lens	41
A3 Case Studies	45
A3.1 Bremen – Using a motivational interviewing approach to engage with families in a disadvantaged neighbourhood	45
A3.2 Zaragoza – Using Youth-centred Participatory Action Research to develop, implement and evaluate interventions in collaboration with children from a socially disadvantaged and culturally diverse neighbourhood	47

## Striving for a systems approach in childhood obesity prevention - A White Paper based on the GrowH! project

### Preface: Rationale, history and finality of the GrowH! White Paper

Obesity is a major well-known but still poorly understood public health problem. This may be the reason why behaviour-oriented prevention programs often have had only limited or short-term effects. In particular socially vulnerable groups, who are affected most, have not been reached successfully. If the known modifiable risk factors were effectively changed in a favourable direction and if this was achieved in the early life course and in the most affected population sub-groups, the burden of obesity and its related cardio-metabolic disorders could be reduced immensely. It has become obvious that the structural factors that shape health related behaviours, i.e. the so-called upstream factors need to be addressed. We must better understand how the social, regulatory and physical environment impedes healthy behaviours. And we have to find out how this obesogenic environment must be changed to sustainably foster such behaviours. Thus, we have to approach the problem from a systems perspective in order to install and maintain healthy lifestyles at the population level with the aim to reverse the current trends in overweight and obesity, to foster prevention of chronic diseases, and to further enhance healthy life expectancy for the people. Without claiming to offer the ultimate solution to the problem, this White Paper takes a first step in the right direction by describing the main building blocks of a systems approach to obesity prevention and by grounding these more theoretical considerations on practical experiences made in two participatory community-based childhood obesity prevention projects that took a systems lens.

The GrowH! project exploited the most recent longitudinal research data to obtain a comprehensive understanding of the quantitative contribution of the known obesity risk factors and their role at different growth phases of children to identify life-course tipping points and critical time windows. These analyses supported the adaptation of novel participatory and even co-creative intervention approaches in youth to develop and test better targeted and more effective primary prevention strategies with a particular focus on vulnerable groups. And finally, the knowledge gained from the empirical part of this project as well as from the experts involved were amalgamated in this White Paper to enable uptake and further development of systems-oriented prevention approaches by public health actors. To this aim, GrowH! addressed three research questions: (1) What is the – possibly age-dependent – impact of known modifiable risk factors at critical transition periods during the early life-course and which hypothetical interventions would result in the strongest reduction of overweight, obesity and their sequelae later in life? (2) Can two different novel participatory intervention approaches that have shown first promising effects be successfully transferred to socially disadvantaged populations in Spain and Germany and can these then be scaled-up sustainably by operational stakeholders? (3) What are the structural and regulatory requirements and conditions for the implementation and up-scaling of the developed intervention approaches onto a regional, national or international level from a whole systems perspective? The answers to these questions will feed into a policy guidance that will be worked out and disseminated for wider use and sustainability of the available evidence in a European context together with public health societies and the WHO.

The first research question was addressed by reviewing the most recent studies on the aetiology of childhood obesity and by re-analysing the data of the IDEFICS/I.Family and the ABCD cohorts, both of which had conducted a deep phenotyping including the assessment of health behaviours, physical examinations and bio-sample measurement of metabolic markers in several thousand children. These data enabled us to assess the factors involved in the development of obesity during the early life-course by quantifying their relative impact, by deriving a life-course model for the development of obesity during growth and by modelling the impact of hypothetical early life interventions. Details of the hypothetical interventions are described in Appendix A.2 of this White Paper.

The second research question was addressed by the adaptation of two participatory local prevention projects that we consider proof-of-feasibility studies serving as case studies for our approach. To this aim we adapted the Guelph Family Health Study from Canada that uses motivational interviewing to induce favourable changes on the family level and implemented it in a socially disadvantaged city district in Bremen, Germany. Additionally, we adapted the Amsterdam Kids in Action study from The Netherlands that uses a participatory action approach to co-create interventions together with children, and implemented it in a socially disadvantaged city district in Zaragoza. Both studies have already shown promising effects in the desired direction in their original settings. The motivational interviewing approach was adapted to the local context and implemented in a diverse city district in Bremen, Germany, while the Youth Participatory Action Research approach was adapted and implemented in a diverse city district in Zaragoza, Spain. Both districts are characterized by high proportions of children from vulnerable population subgroups including those affected by, amongst others, high unemployment, migration background, low income, low education, or single parent settings. Both field interventions were informed by the hypothetical interventions, i.e. by mapping the most effective interventions against the most important risk factors at each critical transition period. Both interventions were implemented with the support of operational stakeholders, i.e. agencies who were already delivering health promotion activities in these communities. At the same time other stakeholders including policy makers were involved to understand the local systemic drivers of overweight and obesity, and to eventually take a systems lens in evaluating the feasibility and transferability of the two intervention approaches. The two case studies are described in detail in Appendix A.3 of this White Paper.

The third research question was addressed by a synthesis of expert knowledge and the lessons learnt from our field interventions to derive evidence-based policy guidance for integration of the targeted interventions into a broader systems approach for obesity prevention. A systems advisory board with experts in developing and implementing corresponding intervention programs provided the necessary expertise to the project during several bi- and multilateral consultation rounds with project partners. This work was guided by the premise that the main drivers for overweight and obesity should be considered as a complex web of underlying societal mechanisms that jointly form a structural threat to the uptake and maintenance of healthy lifestyle patterns seen as crucial in the battle against overweight and obesity. Efforts aimed at modifying behaviour at the individual level should therefore be strongly anchored in a broader “societal DNA for healthy lifestyles”, that acts beyond the control of individuals but yet shapes their behaviour and protects their health in a subliminal way. This dialectic requires a change in perspective among Public Health actors and a more holistic view which the GrowH! project accomplished by considering a systems approach. While evaluating corresponding frameworks and learning from experts in developing and implementing such approaches, their practical implications were critically appraised in a reiterative discourse with all project partners and local stakeholders in the field.

At its outset, this White Paper summarizes the current knowledge on the epidemiology and aetiology of childhood overweight and obesity in the first chapter. Taking a helicopter view, we explain why we are facing a complex systemic problem here and what it would mean to respond to it by taking a systems perspective. The second chapter presents the main building blocks for implementing a systems approach from a theoretical perspective. For those building blocks that we were able to implement in our proof-of-feasibility field studies we confronted the theoretical concepts with our practical experiences and in particular with the perceptions and opinions of the stakeholders with whom we interacted in the cities of Bremen and Zaragoza during the field phase.

This White Paper will be made available to a broad range of stakeholders, including policy makers and public health actors via multiple channels. Its main messages will feed into a short policy guidance document that will be disseminated for wider use and sustainability of the available evidence in Europe and beyond together with public health societies and a multitude of organizations, agencies and institutions devoted to the promotion of population health.

## Chapter 1. Problem statement – childhood obesity as a complex problem

### 1.1 Childhood obesity in Europe

Overweight and(/or) obesity have reached epidemic proportions in the European Region, affecting nearly 60% of adults. Children are also affected, with 7.9% of children younger than 5 years and one in three school-aged children living with overweight/obesity. Prevalence appears to decrease temporarily in the age group 10-19 years with one in four currently living with overweight/obesity. In general, the prevalence of overweight/obesity in the European Region is unacceptably high and no country is on track with strategies to reach the WHO target of halting the rise in obesity and turning the tide by 2025 (1-3). The highest levels of both overweight and obesity are found in Mediterranean and Eastern European countries (3). Of concern, the percentage of children living with overweight/obesity is generally higher among those from families with a low versus high socioeconomic position (3). It has been predicted that due to the health consequences and high prevalence of obesity, the current generation of children may have a shorter life expectancy than their parents (4).

### 1.2 Childhood obesity as a complex systems problem

The mechanisms leading to energy surplus in adipose tissue of the body – the phenotype of (overweight/obesity) - are not fully understood but it is generally accepted that obesity has a multifactorial aetiology. Moreover, factors affecting children's eating and physical activity are influenced by both intrinsic (genetics, age, sex) and environmental (family, peers, community, and society) factors (1).

#### *Regulation of fat stores*

The most basic biological problem underlying overweight/obesity is a disruption of the **innate physiological pathways for energy balance regulation** – i.e. the pathways that keep the amount of fat stored in the human body within certain boundaries. Excessive fat storage triggers a broad series of other disruptive processes in the body that can lead to a number of comorbidities linked to overweight/obesity (like diabetes and other endocrine disorders, musculoskeletal problems, cardiovascular diseases, etc.) and that dramatically increase the risk of premature death (5).

This innate physiological system is very complex in nature and still not fully understood. It has been clearly demonstrated that a specific neurological area in the brain (the hypothalamus) plays a crucial role by integrating metabolic, neurological and endocrine signals coming from different parts of the body and also from other parts of the brain. It is also well accepted that the overall outcome in terms of fat stores is the result of an interplay between a **homeostatic** and a **hedonic system**, both acting via the hypothalamus as central integrator. Indeed, unlike most other physiological systems in the human body (e.g. pH of the blood, body temperature), the regulation of energy balance is not only a homeostatic process silently active beyond human consciousness but is also partly controlled by stimuli coming from other parts of the brain that are involved in mental processes underlying human behaviour and that engage in cognitive, emotional, social, affective, recreational, etc. faculties of the human condition. The latter is usually coined as the **“hedonic system”** as it influences the energy balance system in a way that



does not directly relate to the mere physiological needs and is strongly related with a personality concept known as “pursuit for pleasure” (6-8).

This hedonic system – also very complex and still incompletely understood – in fact constitutes the set of mechanisms through which environmental determinants of human behaviour can interfere with the innate human energy balance physiology and hence forms the mechanistic basis for the so-called “**obesogenic environment paradigm**”. This paradigm (9-10) allows us to examine and progressively understand why and how humans have not adapted to the dominant modern lifestyle - with a broad palette of factors that can disturb the energy balance regulation mainly via diet and activity related behaviour. This paradigm also allows to shift the focus of obesity prevention away from the individual level, and indeed move it to the level of environmental queues and thereby transform its dynamics from an individual behavioural target to addressing a broad societal mechanism for which there is a burden of collective responsibility – this is further elaborated in the next section.

#### *The role of the environment and lifestyle*

In recent years, it has become evident that poor diet and low physical activity are major contributors to the overall burden of the disease and that differences in lifestyle behaviours play an important role in explaining variations in health (2). Recent studies strengthen the evidence of the independent role of added sugar, sugar sweetened beverages and fast food consumption (11-14).

Digital media increases exposure to food marketing that may in itself be related to the same health outcomes as sedentary behaviour, mediated through excessive consumption of highly palatable foods and sugary beverages(20-22).

While extensive digital media time has contributed to the sedentary lifestyles, other environmental factors have reduced the opportunities for physical activity: opportunities to commute to school, being physically active during leisure time and access to activity promoting safe environments have all decreased in the recent years (19).

Low physical activity and excessive sedentary behaviours have also been reported to be associated with overweight/obesity, metabolic disorders and cardiovascular disease in children and adolescents (15-18). Over two thirds of European children and adolescents are insufficiently active (18). Disparities in screen time, sport club participation and active travel to school have been noted among children across European countries (19).

Most living environments in Europe - including the built, social and online environments – are not primarily designed to serve health promoting purposes but serve primarily commercial purposes and thus very often facilitate unhealthy decisions, especially for children from low socioeconomic groups (23-25). For example, these children have limited access to safe and pleasant green areas and higher exposure to marketing of unhealthy foods (26-28).

#### *The societal and public health perspective*

Childhood obesity is thus a multifactorial public health challenge, with the “obesogenic” environment as the main driver. Finegood described the determinants of overweight/obesity as “*function[ing] at multiple levels, with important interactions between these levels*” (24). The interaction of these levels, in nonlinear

patterns, reflects a complex set of cause and effects revealing a system of interacting factors underpinning patterns of overweight/obesity (29)

The UK Government’s Foresight Programme was one of the first sound scientific efforts to describe the complexity of this nexus between environment and human biology in relation to energy balance was done by a group of experts convened under the auspices of (<https://www.gov.uk/government/collections/foresight-projects>). This “Foresight Report” (30) presents a pioneering portrayal of the complex web of obesity causation, whereby determinants and causal pathways of overweight/obesity have been identified and mapped (figure 1).

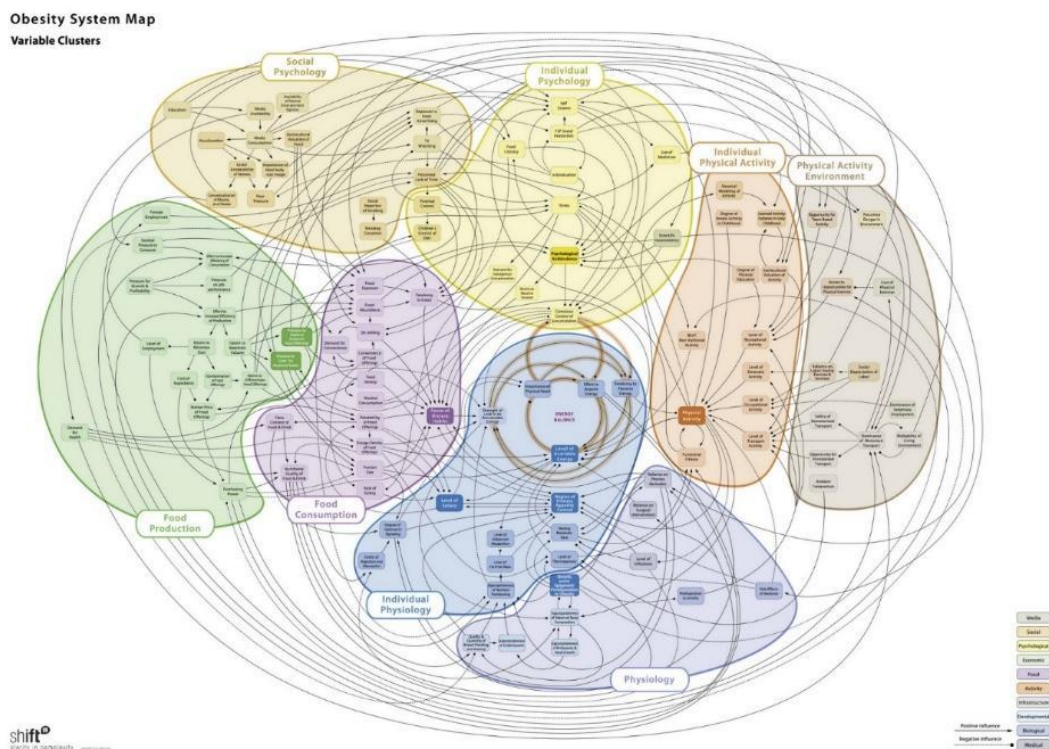


Figure 1. The Obesity System Map (from the Foresight Report (30))

At the core of this “obesity system map” is the “hypothalamus as integrator of energy balance” (also referred to as “the engine”), i.e. the biological entity processing the incoming information from the complex web of both internal signalling and the surrounding environmental levers and barriers vis-à-vis human energy balance. These factors are grouped as thematic clusters (like “Food production”, “Food Consumption”, “Social factors”, “Psychological factors”, the “Economy”, the “Media” etc) and further made explicit through over 100 explanatory factors and more than 300 lines indicating positive and negative feedback loops. In doing so, the Foresight Working Group managed to visualize the obesity system in its most differentiated form, from very proximal factors linked to e.g. individual innate learning abilities with regard to behaviour change to the most distal factors – very remote from any individual control - like physical activity promoting infrastructure, food market pricing mechanisms and fiscal

incentives for the food industry. (<https://www.gov.uk/government/publications/reducing-obesity-future-choices> )

In other words, the Foresight document convincingly shows how modern life conditions and the broader societal context interplay to cause the overweight/obesity epidemic and since its publication in 2007 many experts have engaged in further describing societal mechanisms that can contribute to this process and in elaborating methodological frameworks to address this complex problem. Although this map cannot be considered easily interpretable, its creation engaged a broad range of stakeholders in a dialogue about how to tackle this complex problem (31). Development of the Foresight map has indeed supported the discourse on policy interventions and derivative maps have since been created that can be used to unpack the complexity into more manageable pieces relevant to policy interventions (32).

What can be derived and concluded from the current body of evidence and scientific insights on the societal obesogenic framework is that the overweight/obesity phenotype - a complex interaction between the genotype and the environment-, is in fact **a very contingent phenomenon** at the individual level. Indeed, the point in time and space of an individual's birth and childhood growth and development critically determines the likelihood of becoming overweight/obesity – and therefore the prospect of a compromised life quality and expectancy. In other words, the prevalence of people living with overweight/obesity can be considered a function of the obesogenic propensity of the system in which they live. The more obesogenic living environments are, the harder it becomes for individuals to make healthy behavioural choices and the more likely becomes the onset of unhealthy weight gain while the opposite can be reasonably expected from environments protecting and facilitating healthy weight. This is essentially what was captured in the famous quote by Egger and colleagues (33) when paraphrasing the obesogenic paradigm as the observation that “obesity is a normal (i.e. largely inevitable) response to an abnormal (nocuous) environment”. This perception of the overweight/obesity pandemic adds a strong ethical dimension to an already large societal burden linked to the overweight/obesity epidemic (e.g., societal, medical, economic) and therefore makes the urge of addressing the problem even more compelling.

To conclude, the dramatic increase over the past few decades in prevalence of overweight/obesity worldwide can be primarily **explained by societal, cultural and socio-political governance** factors that escape the control of individual human beings and that characterize and describe societies at the macroscale level – food production and retail system, the built environment and availability of public green spaces, the public health system, workplace design, transportation system, education system and so on. These meso- and macro-level drivers are indeed often denoted with the generic term “**system**”, pinpointing the fact that these phenomena are indeed recognizable as coherent entities but at the same time acknowledging their complex nature. **The use of the term “system” has therefore also gradually been integrated in the mainstream scientific narrative of obesity prevention.** (34)

#### *Systems thinking in the obesity prevention framework*

Ever since it has become apparent that overweight/obesity was taking on epidemic proportions, numerous efforts have been made to develop interventions for treatment and even more so for prevention. Indeed, it is understood since long that primary and primordial prevention are of utmost importance to turn the tide in a sustainable way. However, prevention programs have for a long period been mostly one-dimensional, focusing on one particular target group, one particular setting, one

particular behaviour, one particular theory of change, etc. Over the past decades it has become increasingly clear that such interventions – although useful in themselves in order to increase the overall body of knowledge – eventually fall short in generating the desired effect mostly because of their limited impact intrinsically linked to their isolated position and fragmentary character within a multidimensional obesogenic paradigm.

Interventions that focus on the proximal (behavioural) causes while disregarding the distal causes, i.e. the upstream drivers of human behaviour, are bound to fail (35-37). Thus, it has become apparent that a more holistic approach is necessary and this has led to a gradual increase in the development of so-called “**systems approach framework for obesity prevention**”. This approach is based on **systems science theory** that was originally developed in mathematics, physics and economics sciences, but over time also found its way to very different fields of science, including biomedical science, public health and indeed obesity prevention research (38).

There is no universal definition of what a system is (for an overview and discussion, see 39). At a basic level of common understanding, a system can be seen as a group of interrelated, interdependent, and/or interacting elements that function according to some set of rules, and which together form a collective entity that has some recognizable coherence or congruence and in many cases serves a particular finality. Examples of systems can be e.g. the health care system, the educational system, the food production system, etc. and different systems can agglomerate into larger systems, like e.g. the obesogenic system that in itself consists of several interplaying systems (as described for instance above in the Foresight map – see previous section).

The groundwork for the “systems science approach” was laid by Ludwig von Bertalanffy, the pioneer of general systems theory, who advocated for viewing systems as integrated wholes, highlighting shared principles across different systems (39-40). Norbert Wiener's research on cybernetics furthered this perspective by drawing parallels between biological and mechanical systems, emphasizing the importance of feedback loops in maintaining system stability and adaptability. Jay Forrester, a key figure in the early development of systems thinking, pioneered system dynamics. His models simulated the behaviour of complex systems over time, revealing the unintended consequences of policy interventions and setting the stage for a holistic understanding of interconnected systems (41). As systems thinking gained momentum, influential thinkers from diverse disciplines contributed to its evolution and application in public health. Donella Meadows emphasized the interconnectedness of systems and championed systemic interventions to tackle complex challenges (42). Russell Ackoff broadened the scope with his focus on systemic thinking in management and organizational design, while Jac Vennix explored practical applications of systems thinking through system dynamics modelling and group model building techniques (43). Jonathan Sterman further refined the application of systems thinking in public health by developing simulation models to analyse and forecast the impact of various interventions on obesity rates.

It is fair to say that today large consensus exists among experts with regard to the need to use knowhow from the systems science paradigm in the multidisciplinary and multisector fight against the overweight/obesity pandemic. Illustrative of the change in scientific practice and efforts to better understand the overweight/obesity complexity can be seen in the secular trend in scientific publications that have both “obesity” and “systems science” as keywords. See figure 2 that shows an exponential increase during the past two decades.

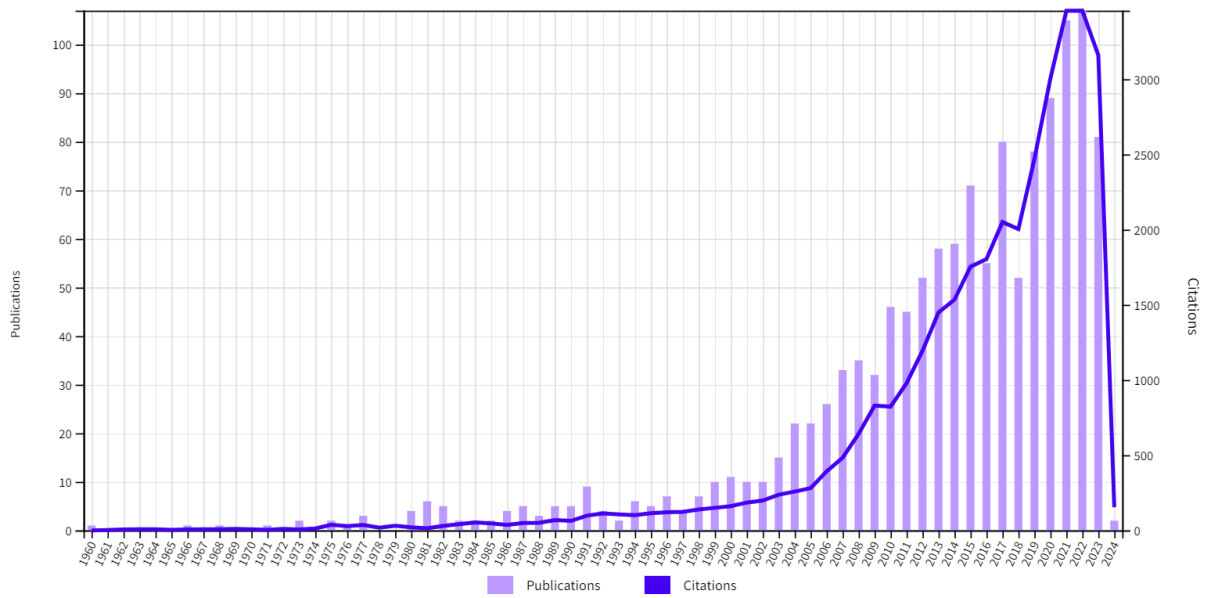


Figure 2. Evolution in the number of peer review publications featuring “obesity” and “system” as MESH terms (Data for 2023 and 2024 incomplete)

### 1.3 Whole systems approaches to childhood obesity prevention

Despite the narrative of “complexity” and “system’s approach” becoming more widespread in the context of obesity, true systems science approaches for overweight/obesity prevention are still rare. This may be due to the mainstream framing of obesity still often as a consequence of individual “lifestyle choices” (44,45) rather than as a societal problem primarily driven by the obesogenic environment. This is the case despite a broad understanding that upstream level factors underpin many of these behaviours (35).

As we move away from the personal responsibility mindset, we must examine the complex drivers that have led to the rise in overweight/obesity in order to develop effective ways to intervene. Systematic review evidence, although far from complete, has concluded that systems science approaches are useful in enhancing the capacity of communities to create healthier environments (46). However, whole systems approaches for overweight/obesity – i.e. intervention strategies underpinned with theory and techniques from systems science to address the obesogenic complexity - are still quite new, hence evidence and models on how to operationalize such approach is still being gathered.

As already pointed out, systems science is an interdisciplinary field that studies the complexity of systems in nature, social, biomedical or any other scientific field. Several systems science methodologies exist – e.g. systems dynamics modelling, agent-based modelling, microsimulation, concept mapping, network analysis and many others – and the decision which methodology (or combination of methods) will be used for a given complex problem – like overweight/obesity - is subject to an ad hoc assessment and deliberation by the actors involved. Recently, the **WHO Regional office for Europe** published a **manual for integrating systems science for NCD policy** development including an overview of approaches, methodologies and practical examples which may provide useful guidance (47). It introduces the topic as follows: *“Systems thinking is a comparatively novel but rapidly developing area of knowledge that can offer a number of approaches to address complex public health problems such as the prevention of non-communicable diseases (NCDs). The use of systems approaches can potentially contribute to the development of effective evidence-informed policies, encourage stakeholder involvement in the decision-making process and improve the coherence of policy implementation”*.

A whole systems approach to childhood obesity prevention does not compare to any individual intervention seeking to change the factors that influence childhood obesity. In simple terms, such a whole systems approach encompasses addressing whole environments that promote the development of childhood obesity, as well as making the best use of communities’ resources, inter-sectoral partnerships and putting local assets to work, and then studying the effects – all based on systems science methods.

Table 1 brings together a number of important concepts and definitions used in the systems dynamics framework as proposed by WHO (from 38), while figure 3 highlights some of the major advantages and benefits from implementing a whole systems approach in public health context.

Table 1. Key concepts in systems thinking

Concept	Definition
Systems thinking	A set of ideas and methods which encourage us to look at the bigger picture
Systems approaches	Specific methods or methodologies (a set of procedures for gathering or interpreting data and/or evidence) informed by systems thinking principles
Leverage point	A point in a system where a small intervention can lead to substantial, system-wide changes
Unintended consequence	Response provoked when intervening in a system that is unintended or difficult to predict (can be harmful or beneficial)
Nonlinear relationship	A relationship between two elements in a system where the cause does not produce a proportional effect
Feedback loop	A closed chain of causal connections resulting in the output of a system or system element feeding back into itself
Delay	An interval of time between cause and effect, which can create instability and fluctuations in system behaviour

Sources: WHO, 2009 (1); Meadows, 2008 (6); Sterman, 2006 (9).

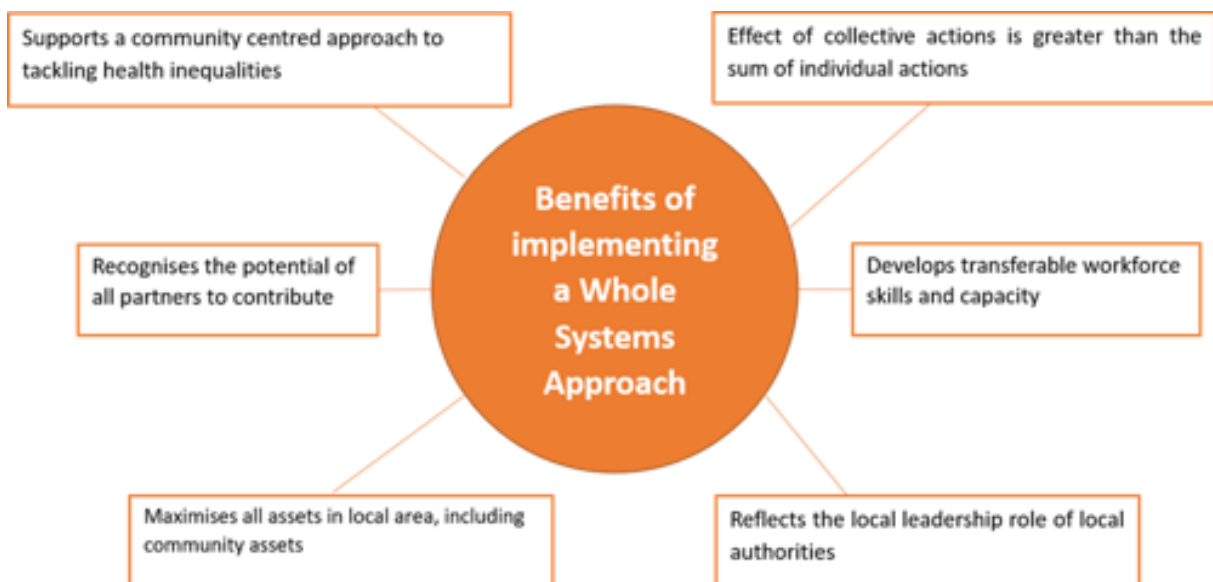


Figure 3. Benefits of implementing a whole systems approach

The framework that is predominantly used in this white paper is **Systems Dynamics** – one of the systems science methods studying the dynamic behaviour of complex systems. An important premise of the method is the understanding that the structure of a system (e.g., its elements, relationships, feedback loops) is often just as important in determining its behaviour as the individual components themselves or in other words that the behaviour of the whole can often not (fully) be explained in terms of the behaviour of the parts.

More specifically for the problem of obesity prevention, the term “**Community Based Systems Dynamics**” is more appropriate as a core feature of this approach is to indeed include and involve in the process the community as a whole, its people, its infrastructure, its organizational features and all the actors and stakeholders that play a role to think, decide and act together in concerted ways vis-à-vis specific problems. For an excellent overview of the components and stepwise implementation of community-based systems dynamics, we refer to an authoritative and comprehensive publication on this topic by Peter Hovmand from Washington University (Saint Louis – USA) (51).

An important step in developing a systems dynamics methodology is through efforts aimed at **understanding the system**. One way of engaging in such efforts is through **systems mapping** and a frequently used mapping tool is the **causal loop diagram** (CLD) (48-50). Such diagrams provide visual representations of the complexity of a problem, depicted in the form of (f)actors, causal relationships, polarity (meaning the direction of impact of one factor on another) and feedback loops (for examples and further description, please see the Appendix A.3). CLDs can provide increased understanding of how different factors and phenomena inform and impact on policy decisions, can highlight the relative importance of different mechanisms and can identify points of leverage and resistance (note: for the latter, mathematical modelling is often the preferred procedure, although not always feasible in practice).

CLD's are often built through so-called **group model building** – i.e. techniques to involve community members, actors and stakeholders in the creation of models to understand the role of (social) determinants of health, in the implementation and scale-up of innovations, and in the development of community prevention strategies. This technique allows to bring together and combine different perspectives vis-à-vis a certain problem and they can also be based on or include experts' views as well as relevant literature (51). A well-known example of a CLD system map is the Foresight map which was introduced earlier in this chapter (30). The Foresight map was developed by experts based on empirical research literature, and it thus creates a predominantly academic perspective on the system in question.

The use of systems approaches in general and of community-based systems dynamics in particular can eventually lead to the identification of – both short and longer term – opportunities for change in a stepwise and participatory building process that should lead towards integrated and profound action for prevention of childhood obesity and to consolidation of the evidence and resulting practices into the development of effective and sustained evidence-informed policies. Indeed, such approaches can take into account the widest possible scope with regard to overweight/obesity drivers in society, encourage citizen and stakeholder involvement in the decision-making process and hence improve the coherence, sustainability and credibility of policy implementation.



## 1.4 Adopting a system’s lens in behaviour-oriented intervention programmes

The GrowH! project was not conceived as a whole systems approach for childhood obesity prevention, but rather adopted a **systems lens**. A systems lens refers to a way of looking at and understanding a problem by reflecting on and analysing structures and patterns in a system that shape lifestyle behaviours. While the project drew on pre-existing experiences with preventive interventions that were implemented in two different contexts (Bremen, Germany; Zaragoza, Spain), taking a systems lens was accomplished by adding methods and techniques from systems dynamics and by reflecting the implementation process from a systems perspective.

Figure 3 provides an overview of the elements in the GrowH! project.

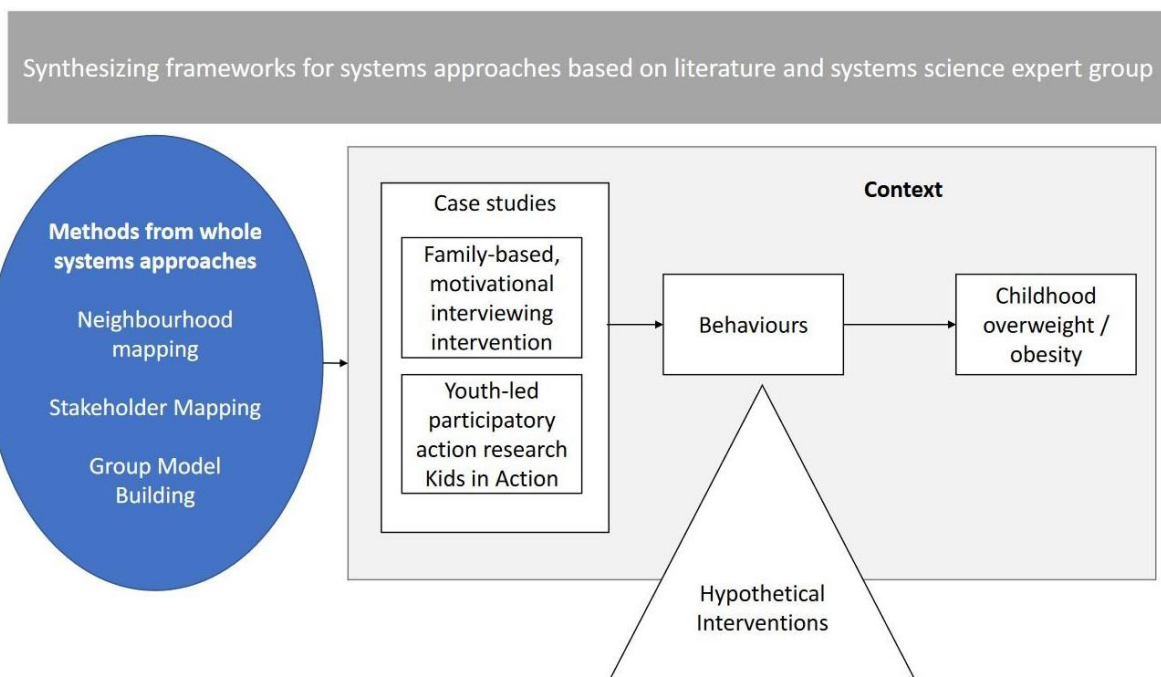


Figure 3. Elements of the GrowH! project.

### *Modelling hypothetical interventions*

As an attempt to deal with the complexity of the various factors related to childhood obesity, a statistical analysis was conducted to estimate the long-term effects of so-called hypothetical interventions based on data from the large-scale European IDEFICS/I.Family cohort study. This analysis showed that the most effective single intervention targets were to meet recommendations regarding screen time and moderate-to-vigorous physical activity. For children of parents with low/medium education level specifically, the most effective intervention target was being a member of a sports club. These results show that targeting screen time, moderate-to-vigorous physical activity and a sports club membership might have the largest impact on children’s weight development in the long run, and therefore are important to include into the overall system of obesity-related factors.

### Case studies: Adapting to pre-existing interventions to a new context

Recent frameworks from implementation science (e.g., the CICI framework, Pfadenhauer et al. 2017) have highlighted the need to carefully consider the role of context when adopting and implementing an intervention. The aim of the case studies was to learn more about the adaptability and transferability of two pre-existing lifestyle intervention approaches that have shown promising results in other contexts (see Table 1). While the two approaches differed substantially, both aimed to reach and engage with socially deprived population groups, giving them a voice and choice when implementing the interventions.

Table 1. Description of the two GrowH! intervention approaches

<b>Context of implementation</b>	Bremen (Germany)	Zaragoza (Spain)
<b>Context of intervention development</b>	Guelph (Canada)	Amsterdam (The Netherlands)
<b>Target group</b>	Families with children aged 3-9 years	Children aged 9-11 years attending primary school (grades 4 and 5)
<b>Setting</b>	Socially deprived and ethnically diverse neighbourhood	Socially deprived and ethnically diverse neighbourhood
<b>Intervention components</b>	<ul style="list-style-type: none"> <li>- Four home visits (approx. 60 min per visit) over 4-6 months</li> <li>- Counselling technique: motivational interviewing</li> <li>- Written information material in easy-to-understand language</li> <li>- Behaviour change incentives</li> </ul>	<ul style="list-style-type: none"> <li>- In total, 20 children participated in so called Action Teams (6-8 children per Action Team; 3 Action Teams installed)</li> <li>- Through (bi)weekly meetings, the Action Teams (1) explored the needs of 9-12-year olds in terms of lifestyle behaviours, and subsequently (2) co-created and implemented actions to address these needs:</li> <li>- The following actions were implemented:               <ol style="list-style-type: none"> <li>1. Cooking workshop</li> <li>2. Olympic sports day</li> </ol> </li> </ul>
<b>Staff</b>	Professional health educators trained in motivational interviewing	An academic researcher to facilitate Action Teams meetings

The implementation of the interventions was preceded by an adaptation phase and/or local needs assessment. For the case study in Bremen, focus group discussions with families from the target groups and with local stakeholder (health educators in primary schools) were conducted to adapt the intervention to the local context. For the case study in Zaragoza, the protocol for conducting participatory action research was adapted to the latest research insights during meetings together with researchers from the pre-existing intervention approach. The facilitating researcher then adapted the protocol to the local context. After the implementation, group discussions with local stakeholders, e.g. staff from

kindergartens, primary schools, community centres, public health authorities and sports associations, and with participating families were carried out to evaluate the contextual fit of the intervention and to gather reflexions about entry points for systems approaches in these settings. A more detailed description of the implementation process can be found in the Appendix A.3.

#### *Using techniques and methods from systems dynamics*

Alongside the implementation of the pre-existing interventions, techniques from systems dynamics were used to gain a deeper understanding of the local obesogenic systems. This is described more in detail in chapter 2.

### **References of chapter 1**

1. World Health Organization. Regional Office for Europe. (2021). Monitoring noncommunicable disease commitments in Europe 2021: are we on track to reach targets 10 years after the Moscow Declaration and First United Nations High-Level Meeting?. World Health Organization. Regional Office for Europe. <https://iris.who.int/handle/10665/350457>
2. NCD Risk Factor Collaboration (NCD-RisC). Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128.9 million children, adolescents, and adults. *Lancet*. 2017 Dec 16;390(10113):2627–42.
3. WHO Regional Office for Europe. WHO European Regional Obesity Report 2022 [Internet]. Copenhagen: WHO Regional Office for Europe; 2022. <https://apps.who.int/iris/handle/10665/353747>
4. Olshansky, S. J.; Passaro, D. J.; Hershov, R. C.; Layden, J.; Carnes, B. A.; Brody, J.; Hayflick, L.; Butler, R. N.; Allison, D. B.; Ludwig, D. S., A potential decline in life expectancy in the United States in the 21st century. *N. Engl. J. Med.* **2005**, 352, (11), 1138-45.
5. Simon Kloock, Christian G. Ziegler, Ulrich Dischinger. Obesity and its comorbidities, current treatment options and future perspectives: Challenging bariatric surgery?. *Pharmacology & Therapeutics* 2023, 1085.
6. Berridge KC, Kringelbach M. Affective neuroscience of pleasure: reward in humans and animals. *Psychopharmacology*, 2008 Aug; 199(3): 457–480.
7. Blum, K, Gondré-Lewis, M, Steinberg B, Elman I, Baron D, Modestino, E et al. Our evolved unique pleasure circuit makes humans different from apes: Reconsideration of data derived from animal studies. *J Syst Integr Neurosci*. 2018 Jun; 4(1): 10.
8. Marty L, Chambaron S. Learned pleasure from eating: An opportunity to promote healthy eating in children? *Appetite*. 2018 Jan 1; 120:265-274
9. Swinburn B, Egger G, Raza F. Dissecting Obesogenic Environments: The Development and Application of a Framework for Identifying and Prioritizing Environmental Interventions for Obesity. *Preventive Medicine*, 1999, 29 (6), 563-570.

- 10 WHO Consultation on Obesity (1999: Geneva, Switzerland) & World Health Organization. (2000). Obesity: preventing and managing the global epidemic : report of a WHO consultation. World Health Organization. <https://iris.who.int/handle/10665/42330>
- 11 Malik VS, Pan A, Willett WC, Hu FB. Sugar-sweetened beverages and weight gain in children and adults: a systematic review and meta-analysis. *Am J Clin Nutr.* 2013;98(4):1084-102.
- 12 Te Morenga L, Mallard S, Mann J. Dietary sugars and body weight: systematic review and meta-analyses of randomised controlled trials and cohort studies. *BMJ.* 2012;346:e7492.
- 13 Welsh JA, Cunningham SA. The role of added sugars in pediatric obesity. *Pediatr Clin North Am.* 2011;58(6):1455-66, xi.
- 14 Rosenheck R. Fast food consumption and increased caloric intake: a systematic review of a trajectory towards weight gain and obesity risk. *Obes Rev.* 2008;9(6):535-47.
- 15 de Moraes AC, Carvalho HB, Siani A, Barba G, Veidebaum T, Tornaritis M, et al. Incidence of high blood pressure in children - effects of physical activity and sedentary behaviors: the IDEFICS study: High blood pressure, lifestyle and children. *International journal of cardiology.* 2015;180:165-70.
- 16 Rey-Lopez JP, Ruiz JR, Vicente-Rodriguez G, Gracia-Marco L, Manios Y, Sjostrom M, et al. Physical activity does not attenuate the obesity risk of TV viewing in youth. *Pediatr Obes.* 2012;7(3):240-50.
- 17 Rey-López JP, Vicente-Rodríguez G, Bueno G, Moreno LA. Sedentary Behaviors and Obesity in Children and Adolescents. In: Moreno LA, Pigeot I, Ahrens W, editors. *Epidemiology of Obesity in Children and Adolescents, Prevalence and Etiology.* Series on Epidemiology and Public Health. New York Dordrecht Heidelberg London: Springer; 2011. p. 367 - 76.
- 18 Dietz WH, Jr., Gortmaker SL. Do we fatten our children at the television set? Obesity and television viewing in children and adolescents. *Pediatrics.* 1985;75(5):807-12.0,11,12)
- 19 Anderson PM, Butcher KE. Childhood obesity: trends and potential causes. *Future Child.* 2006;16(1):19-45.
- 20 Dietz WH, Jr., Gortmaker SL. Do we fatten our children at the television set? Obesity and television viewing in children and adolescents. *Pediatrics.* 1985;75(5):807-12.
- 21 Olafsdottir S, Eiben G, Prell H, Hense S, Lissner L, Marild S, et al. Young children's screen habits are associated with consumption of sweetened beverages independently of parental norms. *Int J Public Health.* 2014;59(1):67-75.
- 22 Story M, Neumark-Sztainer D, French S. Individual and environmental influences on adolescent eating behaviors. *J Am Diet Assoc.* 2002;102(3 Suppl):S40-51.
- 23 Luna Pinzon A, Stronks K, Emke H, van den Eynde E, Altenburg T, Dijkstra SC, et al. Understanding the system dynamics of obesity-related behaviours in 10- to 14-year-old adolescents in Amsterdam from a multi-actor perspective. *Front Public Health.* 2023;11:1128316.

- 24 Prince SA, Lancione S, Lang JJ, Amankwah N, de Groh M, Jaramillo Garcia A, et al. Examining the state, quality and strength of the evidence in the research on built environments and physical activity among children and youth: An overview of reviews from high income countries. *Health Place*. 2022;76:102828.
- 25 Butland B, Jebb S, Kopelmann P, McPherson K, Thomas S, Mardell J, et al. Tackling obesities: Future Choices - Project Report. In: Skills. DoIUA, editor. UK2007.
- 26 Differential exposure to, and potential impact of, unhealthy advertising to children by socio-economic and ethnic groups: A systematic review of the evidence - PubMed [Internet]. [cited 2023 Mar 31]. Available from: <https://pubmed.ncbi.nlm.nih.gov/33073488/>
- 27 Socioeconomic inequalities in the food environment and body composition among school-aged children: a fixed-effects analysis - PubMed [Internet]. [cited 2023 Mar 31]. Available from: <https://pubmed.ncbi.nlm.nih.gov/34389801/>
- 28 Hoffmann E, Barros H, Ribeiro AI. Socioeconomic Inequalities in Green Space Quality and Accessibility- Evidence from a Southern European City. *Int J Environ Res Public Health*. 2017 Aug 15;14(8):916.
- 29 Finegood DT. The Importance of Systems Thinking to Address Obesity. In: Drewnowski A, Rolls BJ, editors. Nestlé Nutrition Institute Workshop Series [Internet]. S. Karger AG; 2012 [cited 2023 Mar 20]. p. 123–37. Available from: <https://www.karger.com/Article/FullText/341308>
- 30 Butland B, Jebb SA, Kopelman P, McPherson K, Thomas S, Mardell J, et al. Foresight: tackling obesities: future choices - project report. London: Department of Innovation, Universities and Skills; 2007.
- 31 King DA, Thomas SM. Science and government. Taking science out of the box—foresight recast. *Science* 2007; 316: 1701–1702.
- 32 Finegood DT, Merth TD, Rutter H. Implications of the foresight obesity system map for solutions to childhood obesity. *Obesity (Silver Spring)*. 2010 Feb;18 Suppl 1:S13-6. doi: 10.1038/oby.2009.426. PMID: 20107455.
- 33 Egger G, Pearson S, Pal S, Swinburn B. Dissecting obesogenic behaviours: the development and application of a test battery for targeting prescription for weight loss. *obesity reviews*. 2007;6.
- 34 Newell B, Proust K, Dyball R, McManus P. Seeing obesity as a systems problem. *N S W Public Health Bull*. 2007 Nov-Dec;18(11-12):214-8. doi: 10.1071/nb07028. PMID: 18093461.
- 35 Swinburn BA, Sacks G, Hall KD, McPherson K, Finegood DT, Moodie ML, et al. The global obesity pandemic: shaped by global drivers and local environments. *The lancet*. 2011;378(9793):804–14.
- 36 Swinburn B, Egger G. The runaway weight gain train: too many accelerators, not enough brakes. *BMJ*. 2004 Sep 25;329(7468):736–9.
- 37 Roberto CA, Swinburn B, Hawkes C, Huang TT, Costa SA, Ashe M, et al. Patchy progress on obesity prevention: emerging examples, entrenched barriers, and new thinking. *The Lancet*. 2015;385(9985):2400–9.
- 38 Don de Savigny and Taghreed Adam (Eds). Systems thinking for health systems strengthening. Alliance for Health Policy and Systems Research, WHO, 2009.

- 39 Arnold R , Wade JP. A Definition of Systems Thinking: A Systems Approach. *Procedia Computer Science* 44, 2015: 669 – 678.
- 40 Bertalanffy, L. von. (1950). An outline of general system theory. *British Journal for the Philosophy of Science*, 1, 114-129.
- 41 Forrester, J. W. (1991). System dynamics and the lessons of 35 years. In K. B. De Greene (Ed.), *A systems-based approach to policymaking* (pp. 199-240). Springer.
- 42 Meadows, D. H., & Wright, D. (2008). *Thinking in systems: A primer*. Chelsea Green Publishing.
- 43 Vennix, J. A. M., Akkermans, H. A., & Rouwette, E. A. J. A. (1998). Group model-building to facilitate organizational change: An exploratory study. *System Dynamics Review*, 13(3), 179-201.
- 44 Robinson, M. and Smith, J.A. (2023), The lazy language of ‘lifestyles’. *Health Promot J Austral*, 34: 3-5.
- 45 Hagens LL, Schmidt LA, Groeniger JO, et al. Why we struggle to make progress in obesity prevention and how we might overcome policy inertia: Lessons from the complexity and political sciences. *Obesity Reviews*. 2024; 25(5):e13705.
- 46 Bagnall AM, Radley D, Jones R, Gately P, Nobles J, Van Dijk M, et al. Whole systems approaches to obesity and other complex public health challenges: a systematic review. *BMC Public Health*. 2019 Jan 3;19(1):8.
- 47 WHO Regional Office for Europe. Systems thinking for noncommunicable disease prevention policy: guidance to bring systems approaches into practice [Internet]. Copenhagen; 2022. Available from: <https://www.who.int/europe/publications/i/item/WHO-EURO-2022-4195-43954-61946>
- 48 Baugh Littlejohns L, Hill C, Neudorf C. Diverse Approaches to Creating and Using Causal Loop Diagrams in Public Health Research: Recommendations From a Scoping Review. *Public Health Rev*. 2021;42:1604352.
- 49 Rod MH, Rod NH, Russo F, Klinker CD, Reis R, Stronks K. Promoting the health of vulnerable populations: Three steps towards a systems-based re-orientation of public health intervention research. *Health Place*. 2023 Mar;80:102984.
- 50 McGill E, Er V, Penney T, Egan M, White M, Meier P, et al. Evaluation of public health interventions from a complex systems perspective: A research methods review. *Soc Sci Med*. 2021 Mar;272:113697.
- 51 Peter Hovmand. *Community Based Systems Dynamics* ISBN 978-1-4614-8762-3 ISBN 978-1-4614-8763-0 (eBook) DOI 10.1007/978-1-4614-8763-0. Springer New York Heidelberg Dordrecht London

## **Chapter 2. Building blocks for the implementation of a systems approach to childhood obesity prevention**

### **2.1 Establishing building blocks for the implementation of a systems approach in childhood obesity prevention**

In this chapter, we delineate building blocks for the implementation of systems approaches for childhood obesity prevention. We draw upon a synthesis of published literature, practical experiences from the GrowH! Interventions, input from local stakeholders where the interventions were implemented, and discussions with the GrowH! Systems Science Advisory Board.

The theoretical foundation for the building blocks is based on our scoping review and expert consultation aimed to create an overview of systems frameworks for childhood obesity prevention (Belmon et al., in progress). The review includes 28 frameworks, which were identified through an extensive database search, grey literature search, and an expert consultation with the GrowH! Systems Advisory Board. Several elements were identified across frameworks, which are integrated into seven building blocks:

1. Building a community partnership
2. Equity and inclusiveness
3. Supporting political environment
4. Understanding the local obesogenic system
5. Adaptive action development, implementation, and evaluation
6. Systematic program coordination
7. Underpin the approach with theory and evidence

In addition, our practical experiences from applying a systems lens to the implementation of the two GrowH! interventions in the city districts Las Fuentes (Zaragoza, Spain) and Osterholz (Bremen, Germany) enriched our understanding of systems dynamics applied to childhood obesity prevention interventions. The GrowH! interventions acted as valuable case studies which not only underscored the importance of understanding systems dynamics but also applied practical tools of systems methodologies (i.e., CLD creation through Group Model Building (GMB)). Furthermore, interviews with key local stakeholders in two different settings as part of the GrowH! project offered valuable insights for the application of systems thinking specifically for childhood obesity prevention. These interviews provided first hand perspectives on the challenges and opportunities associated with potentially implementing a systems approach for childhood obesity prevention. The GrowH! Systems Science Advisory Board further enhanced the discussion by offering specific learnings and suggestions for each building block.

This chapter equips readers with building blocks for implementing a systems approach for childhood obesity prevention. For each building block, we offer a theoretical foundation rooted in current literature, complemented by the practical experiences made in the GrowH! project.

### **2.2 Building a community partnership**

Community partnership development is the collaborative process of building and sustaining relationships between public health entities and community stakeholders. A systems approach recognizes the importance of engaging communities as active participants in the planning, implementation, and

evaluation of the approach and the health promoting actions as part of the approach. Building a community partnership involves forging alliances with local organizations, community leaders, residents, and other key stakeholders to collectively address public health issues. The goal is to create a shared vision, promote community involvement, and leverage local resources and knowledge to design interventions that are culturally sensitive, contextually relevant, and more likely to be embraced by the community. Community partnership development can foster a sense of ownership and empowerment within the community, enhancing the impact and sustainability of the approach. The first step of building a community partnership involves raising awareness of the problem of childhood obesity among stakeholders, and cultivating motivation among such stakeholders to act on the problem. To identify the prevalence of childhood obesity in a community we need to perform a comprehensive analysis of key indicators.

Local stakeholders from the GrowH! interventions (e.g., policy makers, social service workers, healthcare practitioners, educators) highlighted several points regarding community partnership development when discussing how to begin the process of implementing a systems approach for childhood obesity prevention in their community. They emphasized the importance of **leveraging existing community health networks** by identifying and recognizing them to utilize their resources, expertise, and relationships to support efforts targeting childhood obesity. Within the GrowH! project, two notable networks were highlighted: in Las Fuentes, the Community Health Promotion network (Red Sanitaria) composed of local district government, health practitioners working in the district, social services, etc; and in Osterholz, part of the Leibniz Living Lab network, consisting of paediatricians, sports psychologists, health educators, school staff, amongst others.

Stakeholders also stressed the need to **facilitate engagement among key stakeholders** by cultivating relationships with and between stakeholders such as researchers, local healthcare providers, educators, policymakers, community organizations, and residents to ensure broad participation and support for intervention efforts. For example, during CLD building sessions in Las Fuentes, we provided stakeholders with the opportunity to network during a designated portion of the workshop. Additionally, they emphasized the significance of **engaging community leaders** (e.g., religious leaders, educators, non-profit organisers, business leaders, social activist, healthcare professionals) to champion childhood obesity prevention efforts and mobilize support among residents. They recommended leveraging their influence to raise awareness, promote healthy behaviours, and advocate for supportive policy changes. In Las Fuentes, for example, this involved engaging the district's social services, who expressed a long-term commitment to the improvement of children's health in the community. In Bremen, local stakeholders suggested that the engagement of retired players and managers from Werder Bremen football club could positively contribute to a future systems approach in their community. progress in the intervention.

Lastly, stakeholders stressed the importance of developing a **succession plan** to ensure continuity and sustainability of community partnerships in the event of personnel changes or turnover. This involves documenting roles, responsibilities, and institutional knowledge to facilitate smooth transitions and minimize disruptions.



### Key Message

Community partnership development involves collaborative relationship-building, leveraging existing networks and engaging key community leaders in implementing a systems approach.

## 2.3 Equity and inclusiveness

Equity and inclusiveness are fundamental principles for public health programs, also in the case of a systems approach. Equity is defined by the WHO as “the absence of unfair, avoidable or remediable differences among groups of people, whether those groups are defined socially, economically, demographically, or geographically or by other dimensions of inequality (e.g. sex, gender, ethnicity, disability, or sexual orientation)”. In the context of childhood obesity prevention, ensuring equity and inclusiveness means **acknowledging and addressing the social, economic, and environmental factors that contribute to disparities in health outcomes** among different populations. A systems approach recognizes that these disparities are not simply the result of individual choices or behaviours but are deeply rooted in systemic inequities that create barriers to health and well-being.

By prioritizing equity and inclusiveness, a systems approach to childhood obesity prevention aims to dismantle these barriers and create environments that support all children in leading healthy lives. This requires engaging with communities to **understand their unique needs, priorities, and challenges**, and co-creating actions that are responsive to these realities.

We need to ensure that public health interventions are not only effective but also **just and fair**. This means actively working to reduce disparities in access to resources and opportunities, advocating for policies that promote social and economic justice, and empowering vulnerable communities to participate in decision-making processes that affect their health.

In the GrowH! interventions, the selection of implementation locations followed the principle of proportionate universalism, targeting vulnerable neighbourhoods with a higher concentration of families with a lower socioeconomic position to ensure that resources were directed where they were most needed. In Zaragoza, the participatory research process embraced inclusiveness by actively involving children in shaping the program to meet their needs and preferences and allowing for the incorporation of diverse perspectives. In Bremen, families were guided to tailor the program to their preferences, such as choosing the location for meetings with health educators and selecting areas of focus for improvement within their family environments. However, despite these efforts, enrolling families in the intervention in Osterholz turned out to be challenging. Contacting families via trusted community members and word-of-mouth were the most successful recruitment channels.

### Key Message

Prioritizing equity and inclusiveness includes addressing disparities and promoting fairness in access to resources and opportunities through active involvement of vulnerable groups.

## 2.4 Supporting political environment

A supporting political environment can be considered as a set of favourable political conditions, policies, and attitudes that facilitate and encourage the implementation, sustainability, and impact of a systems approach. Factors that are important to consider are policies that act as enablers or barriers to successful implementation, and the allocation of sufficient resources for a sustainable implementation of the approach. The local stakeholders within GrowH! suggested that **leveraging existing political engagement** was an important step if a systems approach for childhood obesity prevention was going to be implemented in their community.

The first step to establishing political support is to **assess the extent of current political support within the community**. This involves analysing existing policies, attitudes, and conditions that may either facilitate or hinder the implementation, sustainability, and impact of the whole systems approach. In the GrowH! project, it was evident that political engagement regarding the promotion of healthy behaviours among children existed in the communities of Osterholz and Las Fuentes. Specifically, there were several publicly funded health promotion initiatives in place, such as health educators in primary schools and neighbourhood health educators in Osterholz. Furthermore, the local district government of Las Fuentes is actively involved in the local community health network (Red Sanitaria) of the district, participating in local events and initiatives organised by the network (e.g., Feria Sanitaria).

The next step to gain political support in the community is to **collaborate with local governmental officials, policymakers, and community leaders dedicated to promoting children's health**. For example, patronage of a systems approach by the local minister of health was mentioned by the local stakeholders in Osterholz as a realistic and effective option to gain political support and create commitment among the network partners. However, it's important to acknowledge that such collaboration may not always be feasible. In some instances, as observed in Las Fuentes, involving the local district government during CLD building workshops and the implementation of project actions was not possible. This absence limited opportunities for advocacy, and resource allocation. This highlights the need for adaptability and alternative strategies to ensure collaboration.

Ongoing political support is vital for the successful implementation of a systems approach. Regardless of changes in political leadership or party affiliation, sustained support from policymakers and governmental officials is essential to ensure the continuity and effectiveness of intervention efforts. The priorities and agendas of decision-makers significantly influence the allocation of resources, policy development, and implementation strategies related to public health initiatives. Therefore, fostering ongoing political support requires building relationships and advocating for the prioritization of children's health across party lines and administrative changes. Stakeholders can work collaboratively to cultivate a political environment conducive to sustained investment and commitment to addressing childhood obesity within the broader context of public health agendas.

### Key Message

A supportive political environment is important in the successful application of a systems approach, requiring an assessment of current political support within the community and ongoing collaboration with local officials to leverage existing resources and potential funding partnerships.

## 2.5 Understanding the local obesogenic system

Understanding the local obesogenic system involves gaining a comprehensive view of the unique characteristics, dynamics, and stakeholders underlying childhood obesity. Key characteristics include amongst others sociocultural influences, geographic and environmental conditions, healthcare infrastructure, community dynamics, the policy landscape. A **contextual analysis** is suggested to achieve an in-depth understanding.

In the GrowH! project we conducted such a contextual analysis through **systems mapping**. Systems mapping is a set of methods used in the field of systems science, specifically systems dynamics, to create visual depictions of a system which enable researchers to analyse them (76). Systems mapping showcases the elements (or variables), relationships, feedback loops, and emergent trends of a system, which in turn allow a deeper insight into its complex dynamic. Within GrowH!, three systems mapping methods were used to perform such a context analysis: stakeholder analysis, community asset mapping and Causal Loop Diagram (CLD) building.

Within a **stakeholder analysis** qualitative information is systematically gathered and analysed to identify and visually depict the relevant stakeholders related to a project, as well as their perspectives, affiliations, interests, and interactions (77-79). In the context of the GrowH! project, a stakeholder analysis was conducted to identify the key stakeholders that can influence the obesogenic system in the city districts Las Fuentes and Osterholz. Such analysis promotes that the important stakeholders are being recognized and considered throughout the approach. Key stakeholders were invited to participate in the subsequent CLD building sessions, ensuring that complementary voices were reflected in the CLDs. In the case of Las Fuentes, it identified a supermarket chain and a municipal sports centre as key partners to involve in the initiatives co-created by school children to promote healthy behaviours in their neighbourhood and among their peers. It also pinpointed potential stakeholders who could contribute to the local dissemination of activities, like the district's Social Services in Las Fuentes. This comprehensive process establishes a foundation for effective collaboration and engagement within the local system, aligning stakeholders' efforts towards shared goals and maximizing the impact of a systems approach.

Through **community asset mapping** the available resources in a specified geographical region relating to specific areas of interest are identified (McKnight, 2010; Turin et al, 2019; Luo et al., 2023). Within the GrowH! project, community asset mapping was used to identify assets related to childhood obesity prevention in the two districts where the GrowH! interventions took place. Asset mapping deepened our understanding of the obesogenic system of those two communities by identifying factors within it, specifically resources relating to food, exercise, green spaces, community centres, government sites, medical infrastructure, education, drinking water, and pre-existing initiatives. For example, pre-existing initiatives relating to the promotion of healthy behaviours among children and families within the context of Las Fuentes and Osterholz were identified, such as "Meriendas Saludables" by the Fundación el Tranvia and the "Bremer Bündnis für Bewegung" in Osterholz. Furthermore, we uncovered characteristics of the community that favoured unhealthy behaviours related to obesity, such as the presence of food retail stores, parks, lack of cycling paths, and unsafe areas. For example, limited diversity in food retail stores in Osterholz, predominantly comprising big supermarket chains with few small food businesses or discounters, limits the accessibility of affordable healthy food options for its residents, while the limited availability of bike lanes in Las Fuentes could deter children from engaging in active transport. Overall, the community asset mapping helped to identify factors that either supported or hindered the

implementation of the GrowH! intervention strategies. It also highlighted opportunities to integrate current approaches with existing activities or organizations, such as community health promotion networks.

A **Causal Loop Diagram (CLD)** is a conceptual model that illustrates the behaviour of a system – or a subsystem – by depicting its elements (or variables), causal relationships, and underlying mechanisms (80, 81). The diagram is made up of a set of words and arrows interlinked between each other, featuring positive and negative causal links, or reinforcing and balancing feedback loops. CLDs serve as valuable tools for mapping various facets of the community pertinent to childhood obesity prevention from a systemic viewpoint. For instance, they can elucidate the multifaceted drivers contributing to obesity within a given context and identify the complex array of variables impeding the effective implementation of public health initiatives targeting childhood obesity. CLD building encompasses a range of methodologies. Researchers may opt to extract pertinent data from scientific literature, synthesizing findings to inform the diagram's structure and content (Waterlander et al., 2020). In addition, stakeholders can be engaged in the process of creating a CLD through Group Model Building (GMB) to capture diverse perspectives and insights regarding the systems' dynamics. Once constructed, CLDs provide a comprehensive visualization of the interrelationships between various variables influencing childhood obesity and the underlying dynamic behaviours exhibited by the system over time. This holistic understanding enables stakeholders and policy makers to identify key places to intervene within the obesogenic system, i.e., key modifiable points which if targeted through initiatives or policy changes disrupt the system and lead to significant improvements in preventing childhood obesity. Within GrowH!, we applied local GMB sessions to build CLDs with key stakeholders identified through the stakeholder analysis. In the Appendix A.3, we illustrate how CLDs have a role in applying a system's lens when targeting individual behaviours. We utilize the CLD by Luna-Pinzon et al. (2023) to locate individual behaviours such as sleep duration or physical activity into the overall system of obesity-related factors (see Section A2.2).

#### Key Message

Performing a contextual analysis using system mapping methodologies will support in understanding the local context and obesogenic system.

## 2.6 Adaptive action development, implementation and evaluation

Rather than relying on single interventions, coordinated actions should target key places to intervene in the obesogenic system. Actions can be collaboratively developed and implemented by key stakeholders. Local stakeholders emphasized the importance of recognizing, respecting, and potentially integrating ongoing community programs when implementing a systems approach. Thus, we advocate for a comprehensive analysis of existing programs and initiatives during the development of actions to determine whether ongoing efforts align with the places to intervene in the system.

**Adaptive action development** within a systems approach involves an iterative and continuous process of piloting, implementing, and evaluating actions to refine their relevance and intended results. This dynamic approach recognizes that initial actions may require modification based on real-world feedback and (un)expected outcomes. Pilot testing allows for the exploration of feasibility, acceptability, and initial impact before full-scale implementation, providing valuable insights into what works and what needs

adjustment. Based on the results of these pilots, actions are iteratively adapted to better align with the needs and realities of the community, ensuring that interventions remain responsive and contextually appropriate.

The GrowH! family-based intervention in Bremen executed a traditional adaptation phase, including the adaptation of an existing intervention to a new context. In the GrowH! intervention in Zaragoza, an adaptive action development process was implemented as this was part of the dynamic and collaborative approach to the intervention design. Through the engagement of participatory action teams, children were guided to select action ideas that were both feasible and could potentially create meaningful impact. Actions were co-created based on the specific needs identified within their community, the preferences of the children involved, and the existing local infrastructure. The actions were pilot tested and implemented within this structure. This inclusive approach not only ensured that interventions were tailored to the local context but also fostered a sense of ownership and empowerment among the action team children as part of the community. **Monitoring and evaluation** within systems approaches for childhood obesity prevention represent a departure from traditional evaluation methods which follow a linear process of planning, implementation monitoring, steering, and completion. While the GrowH! interventions employed a more conventional approach, focusing on pre- and post-intervention measurements of health behaviours and anthropometric indicators, systems evaluations emphasize continuous monitoring and evaluation of implemented actions over time. It takes the complexities into account of an ever-changing environment and works with short-cycle iterations, collecting user feedback as soon as possible and adapting actions based on the collected feedback. This approach encompasses not only the intended effects of interventions but also considers unintended consequences and changes within the system over time because of these actions. Through systematic monitoring, potential gaps or areas requiring adaptation can be identified, enabling proactive adaptations to address emerging challenges or capitalize on new opportunities. This may be accomplished by comparing CLDs from different time points or utilizing techniques like ripple effects mapping (Nobles et al, 2022) or process monitoring (Maitland et al. 2021). Ripple effects mapping can capture wider impacts and the adaptive nature of a systems approach, while process monitoring involves the ongoing tracking of implemented actions and their impact on the broader system.

Continuous short-cycle iterations for monitoring changes in the system involves ongoing, rapid feedback to track the implementation and adaptation of actions within complex systems. These iterations prioritize **real-time adjustments based on emerging insights**, fostering a dynamic and responsive approach to interventions. In contrast, traditional outcome evaluations for childhood obesity interventions usually gauge effectiveness by measuring behavioural and environmental outcomes before and after intervention using predetermined metrics and endpoints. While both approaches contribute to understanding the impact of interventions, continuous short-cycle iterations emphasize process-oriented learning and adaptation, whereas outcome evaluations focus on assessing the achievement of specific outcomes and targets.

To be able to have continuous adaptive development, implementation, and evaluation of actions, local stakeholders (e.g., community leaders, healthcare providers, and educators) must be **equipped with the skills and knowledge to effectively integrate systems dynamics within the local context**. Our interviews with GrowH! local stakeholders revealed that they were not acquainted with specific theories or methods of systems approaches. Providing **training about systems dynamics** may transfer the necessary concepts to implement systems approaches. Local stakeholders suggested community-based training sessions as a

valuable activity for them to gain hands-on experience and practical guidance on applying systems dynamics to local issues. They emphasized the importance of illustrating the benefits of a systems approach through successful case studies and tailoring the sessions to the local context.

#### Key Message

Part of a systems approach is the adaptive nature of the development, implementation, monitoring, and evaluation of actions, integrated into existing community structures and programs.

## 2.7 Systematic program coordination

Within a systems approach, systematic program coordination involves the development and management of the systems approach itself. This coordination ensures that all components of the system are integrated efficiently, goals are aligned, resources are optimized, and processes are streamlined to achieve the desired outcomes effectively. Additionally, it fosters collaboration among stakeholders, enhances communication, and allows for continuous monitoring and adaptation, thereby increasing the overall effectiveness and success of the program.

To do this, a systems approach requires the **development and execution of a clear program plan**. Said plan lays out clear and measurable objectives, timelines, and milestones; and clearly states resource allocation including funding, personnel, and materials. This ensures that the program is well-defined to guide its implementation by tracking its progress, adjusting strategies as needed, and maintaining accountability. Within the GrowH! project, local stakeholders proposed several strategies for creating and executing such a plan. Firstly they emphasized the importance of defining and expressing clear and measurable aims and timelines for a systems approach, ensuring they are achievable and comprehensible to everyone involved. They also stressed the importance of **creating a clear and reliable governance structure** that defines roles, responsibilities, and decision-making processes within the systems approach. Within this governance structure, public health researchers play a vital role in generating evidence, jumpstarting the systems approach collaboration with stakeholders, guiding the direction of the approach and evaluating actions. Other stakeholders, such as government agencies, healthcare providers, schools, community organizations, and the food industry, collaborate to implement actions tailored to the local context, aiming to create supportive environments for healthy behaviours among children and families. Additionally, stakeholders further emphasized the importance of forming a **core working group** involving key stakeholders to facilitate strategic planning and maintain expertise throughout the program. However, they also highlighted the necessity of **maintaining an open network structure** to encourage inclusive and broad participation from additional stakeholders. Furthermore, they stressed the importance of **implementing efficient working protocols** to enhance communication, collaboration, and accountability. These working protocols would include standardized meeting schedules, work plans, and reporting mechanisms to ensure transparency and progress tracking. Finally, stakeholders also noted the crucial aspect of flexibility in program planning to adapt to any circumstances during implementation and consider the needs of the community network, such as meetings and collaboration.

Funding constitutes a vital pillar that supports the implementation of a systems approach, playing an important role in shaping the operational efficacy and longevity. **Diversification of funds** emerges as an

important strategy to mitigate risks and ensure sustained support of a systems approach. Beyond reliance solely on public health organisms, local stakeholders in the GrowH! project recognize the necessity of exploring alternative funding avenues such as private sector partnerships, philanthropic grants, and collaborative ventures (e.g., the urban planning department, European Social Fund, welfare foundations). For instance, discussions among stakeholders in Osterholz have highlighted the potential of statutory health insurance as a reliable initial source, ensuring stability for the program's initial phases.

Finally, stakeholders advocated for promoting **resource mobilization and sharing** among partner organizations (e.g., meeting rooms, sports halls, logistics for events) to foster collaboration and maximize impact within the community. For instance, within the context of GrowH!, specifically in Las Fuentes, actions co-developed with children promoted local stakeholders to engage with schools to facilitate implementation. This collaborative endeavour involved the municipal sport centre providing sports equipment for a sports day, a local supermarket supplying food for cooking workshops, and schools offering spaces to host these activities.

**Effective leadership** plays a pivotal role in guiding the program's direction, aligning the participants (i.e., researchers, stakeholders, and the institutions they represent, etc.), stimulating commitment and innovation among team members, and overcoming organizational barriers to ensure the program's success and sustainability.

Finally, clear, positive, inclusive, and tailored **communication and marketing strategies** of the approach and the incorporated implemented actions play a pivotal role. Effective communication fosters understanding, engagement, and participation among diverse stakeholders within the community. By ensuring clarity in messaging, actions and the intention behind the project can resonate with various stakeholders. Moreover, the adaptation of communication strategies to the specific needs and preferences of different groups enhances their relevance and efficacy, facilitating meaningful dialogue and collaboration.

Stakeholders highlighted the need to clearly express the goals of the systems approach in a way that all stakeholders involved can easily grasp and get on board despite their differences. Also, the language proficiency of GrowH! researchers and collaborators was vital for reaching out to families and delivering the family-based intervention, especially for those with low proficiency of German language. Ultimately, finding the right language and methods to communicate effectively is essential for shifting power dynamics from experts to the community. For example, in Las Fuentes, the community health network was identified as an appropriate intermediary to communicate with the community.

#### **Key Message**

Systematic program coordination involves clear planning, management of interconnected components, collaboration, leadership, strategic funding diversification for sustained implementation, and inclusive communication strategies to engage the community.

## 2.8 Underpin the approach with theory and evidence

Underpinning the approach with theory and evidence ensures that the approach is rooted in a comprehensive understanding of the multifaceted factors contributing to childhood obesity and incorporates strategies for an effective approach.

By **incorporating existing theories and evidence** from the field of public health and other fields, a systems approach – like any approach – can capitalise on existing evidence and the collective knowledge base of the scientific community. This knowledge base not only **informs the selection of intervention strategies** but also **guides the development of tailored actions** within the systems approach that address the unique needs and contexts of diverse populations. By incorporating what is already known and understood, the approach can focus on innovative solutions and novel applications to achieve meaningful and sustainable change in childhood obesity.

A concrete illustration of underpinning interventions with theory and evidence can be found in the two GrowH! interventions implemented in Zaragoza and Bremen. In Zaragoza, the intervention design process followed the Intervention Mapping protocol, which involved selecting theoretical methods that aligned with the actions developed by participatory action teams. Conversely, the intervention in Bremen was built upon the theoretical foundation of motivational interviewing, a well-established approach for promoting behaviour change through collaborative, goal-oriented conversations.

Integrating existing theory and evidence within group model building sessions with diverse stakeholder groups serves as a cornerstone for effective systems approaches. Practically, the integration of existing evidence and theory within group model building sessions involves several steps. First, facilitators compile relevant literature, data, and expert insights on the topic at hand, ensuring that participants have access to a comprehensive evidence base. During the sessions, stakeholders are guided through activities such as creating a CLD, where they visually map out the interconnected factors contributing to the problem under consideration. Throughout this process, facilitators prompt participants to draw upon their knowledge of existing theories and evidence to identify key variables, feedback loops, and places to intervene within the system.

### Key Message

It is important to equip stakeholders with the knowledge and skills to incorporate existing theory and evidence into the intervention development within the local context, and with that, ground the approach in established theories and evidence.

## Conclusion

This chapter summarises the building blocks for the implementation of a systems approach to childhood obesity prevention derived from theoretical frameworks and provides related real-world experiences from the GrowH! project. The insights may offer guidance to public health stakeholders regarding understanding of the local system through comprehensive research, developing and implementing dynamic actions with thorough evaluation, systematic organization, fostering community partnerships, and securing political support to sustain the approach and ultimately achieve systematic changes. By following the blocks described above, local stakeholders may work towards effectively applying a systems approach to childhood obesity prevention and thus promote a healthier future for children worldwide.



## References of chapter 2

World Health Organization. (2022). Systems thinking for noncommunicable disease prevention policy: guidance to bring systems approaches into practice (No. WHO/EURO: 2022-4195-43954-61946). World Health Organization. Regional Office for Europe.

World Health Organization. (n.d.). Health equity. Retrieved June 28, 2024, from [https://www.who.int/health-topics/health-equity#tab=tab\\_1](https://www.who.int/health-topics/health-equity#tab=tab_1)

Nobles, J., Wheeler, J., Dunleavy-Harris, K., Holmes, R., Inman-Ward, A., Potts, A., ... & Foster, C. (2022). Ripple effects mapping: capturing the wider impacts of systems change efforts in public health. *BMC Medical Research Methodology*, 22(1), 72.

McKnight, J. (2010). Asset mapping in communities. *Health assets in a global context: theory, methods, action*, 59-76.

Turin, T. C., Shahid, M., & Vaska, M. (2019). Asset mapping as a tool for identifying resources in Community Health: A Methodological overview. *Journal of Biomedical Analytics*, 2(1), 13-25.

Luo, Y., Ruggiano, N., Bolt, D., Witt, J. P., Anderson, M., Gray, J., & Jiang, Z. (2023). Community asset mapping in public health: a review of applications and approaches. *Social Work in Public Health*, 38(3), 171-181.

Laura Belmon (VUMC), Alejandra Sotomayor Sainz, Heide Busse, Irma Huiberts, Stefanie Vandevijvere, Lara Christianson, Wolfgang Ahrens, Stefaan DeHenauw, Teatske Altenburg, on behalf of the GrowH! consortium (In progress). System frameworks for the prevention of childhood obesity prevention: a scoping review

## **Chapter 3. How to address the obesogenic environment in childhood obesity prevention: key learnings from the GrowH! project**

### Adopting a “Systems Lens”

The GrowH! White Paper was conceived as a document that should integrate all the knowledge and knowhow collected and built up in the course of the GrowH! project – a collaborative childhood obesity prevention effort granted within the European JPI (Joint Programming Initiative) framework “Healthy Diet for a Healthy Life”.

The GrowH! project’s main objectives and research outline has been developed against the background of the overweight/obesity pandemic and was intended to contribute to the body of scientific evidence on how to address this global challenge. For this purpose, the project elaborated a scientific protocol and strategy for two feasibility studies with regard to the implementation of specific overweight/obesity preventive efforts that had been tested already in other regions and that had shown promising results. Both studies involved working directly with people – respectively school children from a deprived urban area in a city district of Zaragoza (Spain) and low-income households in a culturally diverse city district of Bremen (Germany) – and were essentially based on two distinct approaches for overweight/obesity prevention, respectively participatory action research for overweight/obesity in Spain and the technique of motivational interviewing in Germany.

Obviously, both approaches have the finality to influence people’s behaviour, i.e. enhancing individuals’ capacity for energy balance control through adoption/consolidation of a lifestyle with mainly adequate sleep and activity patterns and with a well-balanced diet as cornerstones for overweight/obesity prevention.

However, from the first discussions about the project backbone and architecture, the GrowH! researchers realised that the project should not only focus on the individual in a direct way – through direct action on proximal determinants of behaviour - but also should had to take on board the totality of the much wider set of drivers that create the environment (physical and societal) in which people live and that are beyond individual control – this is represented by embracing also the dimension of “systems thinking” in the GrowH! project.

Indeed, as elaborated more extensively in chapter 1, the body of scientific evidence with regard to primordial prevention of overweight/obesity – especially in childhood – points at the need for structural and systemic changes that – for the largest part – are effectuated at the political, community and societal level and not only directly at the individual level. In order to meet this need, systems science has been advocated as the methodological framework to work with.

One of the first – rather naïve – underlying considerations is the simple – but obvious - fact that both types of interventions tested for feasibility in the GrowH! project (for details, please see appendix A.3), focus on phenomena that never occur in isolation. In the case of the Zaragoza study for instance, schoolchildren have been successfully involved in the co-creation of a behaviour change program. However, such PAR (Participatory Action Research) program by itself cannot address the full picture of the broader overweight/obesity promoting contexts that drive these children’s behaviour. They live for instance in socio-economically deprived areas which is in itself an important determinant of overweight/obesity.

These children often live in poor housing conditions, spending lots of time on their own, with large amounts of screen time, often have parents that face subsistence hardship and may not have time for cooking nutritious meals nor spending a lot of time on adequate parenting practices for healthy lifestyles. Often, these children face a lack of activity promoting infrastructure in the neighbourhood, are exposed to aggressive marketing strategies for junk food through different channels and media and moreover they often live in areas that have been described as food deserts – neighbourhoods where almost no healthy foods can be found and highly palatable junk food is available at all times and at every corner. These and many other factors cannot be addressed by a PAR program alone.

Mutatis mutandis, similar considerations can be made for the motivational interviewing intervention that was done in Bremen.

For this reason, the GrowH! project has indeed taken on board a so-called “systems lens” in order to enrich the information gained from the setting-based interventions – respectively schools and households - with relevant information and input from a broader systems perspective. In other words, the GrowH! project has tried to work its way from within the setting of a specific intervention towards the broader systems layers that surround that setting and in doing so, identify additional pieces of a jigsaw of wider determinants and mechanisms for unhealthy behaviours. A stepwise and structured process to visualize relevant cogs in the obesogenic dynamics and gradually build up a data matrix that allows to identify clues for further actions, initiatives and regulatory frameworks. It is a bottom-up approach to look from within the specific setting of an intervention to a broader outlook in which the more distal drivers of the behaviour come into the picture and unveil the potential for concerted action. The finality of this approach is to empirically build knowledge about obesity prevention that – to our knowledge – has not been revealed before and in a form that has not – or only rarely - been attempted before. This new package of knowledge can in a later stage be further tested on its generalizability in other settings, at higher scales and in other jurisdictions.

This GrowH! effort of visualizing the broader picture is mainly done through the systems mapping effort (see Appendix A.2.1 for details on this methodology) from which it was possible to come to a better understanding of dynamics and from which also the building blocks of a systems approach (described in chapter 2) have been distilled.

Overall, the GrowH! White Paper represents a considerable effort to bridge the gap between on one hand the implementation of particular intervention efforts that have shown a potential within specific settings (respectively primary school setting and a setting of socioeconomically deprived households) and on the other hand the need for articulating the specificities of the settings within the broader space of stakeholders, opinion leaders, politicians and any other local actors with influence and/or power to change specific loops in the system for the better.

This effort has been established through a combination of literature search, discussions with systems experts, fieldwork with disadvantaged population sub-groups and qualitative research involving key persons and organisations that can have an influence of the obesogenic framework and its dynamics.

### Systems lens approach: a model based on the GrowH! experience

On the basis of the process described in the previous section, the GrowH! research community – i.e. all the researchers from the project together with the systems experts form the advisory board and all the people that have been interviewed and surveyed – has summarized the key learnings from the project in a **five point principles pamphlet for a systems lens approach** for overweight/obesity prevention that constitutes a useful basis for a modus operandi in the context of overweight/obesity prevention and that can serve as a cornerstone and benchmark for further dissemination and sensitization on this topic at different levels.

1) The notion of “**systems thinking**” should become the **standard attitude** in the minds of all people that work in the field of overweight/obesity and/or have the capacity to make things happen at the societal or political level. Indeed, many people still think in one- or oligo-dimensional terms vis-à-vis the prevention of overweight/obesity and this not only hampers or delays the necessary transition towards systems actions but can also be a serious threat for concerted action at a higher integrated systems level.

Therefore “systems thinking” should be the major key word in all academic, societal and political thinking around obesity – and for that matter around all chronic lifestyle related diseases. Only by adopting a general determination on the need for systems thinking, the process of building further on the knowledge and practice for installing the societal context that facilitates sustainable change in lifestyle can succeed.

2) Principles of systems thinking should be part of **training in all curricula for health professionals and health care managers**. By adopting this basic training principle, a strong foundation and capacity for systems approach can be established and actors from different scientific backgrounds can learn to collaborate within a framework of common understanding for systems approach in such a way that complementary expertise from different fields can converge towards a common finality for overweight/obesity prevention.

3) All public health actions on overweight/obesity prevention within a given area should engage in building a “**Community systems action platform**” bringing together all resources and all stakeholders with an interest in overweight/obesity prevention – politicians, NGO’s, private sector representatives, citizens, etc.

Such platform should engage in mapping existing community health networks and identifying community leaders for health and should start the co-creative process for overweight/obesity prevention via systems approach.

**Leadership** is essential in obesity prevention, providing direction, inspiration, and advocacy for healthier communities. Effective leaders champion initiatives that promote healthy lifestyles, advocate for systemic changes to reduce barriers to nutritious food and physical activity, and inspire collective action across sectors.

Around the appropriate leadership, a **governance structure** should be built that allows inter-sectoral and multi-network collaboration and can lead to developing a shared vision and a fair division of responsibilities and tasks.

4) The community systems action platform – the cockpit for the systems approach for overweight/obesity prevention programs - should build a strategy and **protocol** with a clear description of the stepwise deployment of the “**systems mapping**” and the toolbox that will be used for that (e.g. agent based modelling, group model building, etc) and the appropriate tailored action plan that follows from the systems mapping analysis.

We thereby strongly recommend to use the WHO guidance as a basis for further harmonizing the efforts for systems approach across countries (see chapter 1)

5) As already stipulated in chapter 1, it is strongly recommended to embed the efforts for obesity (and chronic disease) prevention through systems approach into a **broader common agenda for addressing major societal challenges**, that also need to be tackled via multidisciplinary systems science approaches. Indeed, there is substantial evidence that these big challenges - like the planetary health status, the “one health” challenge, the biodiversity loss problem, climate change, etc. (in other words mainly the effect of the so-called anthropocene) are fuelled by a common set of distal overarching driving forces that root into the major faculties of human activities - energy systems, food production systems, land use, the use of planetary resources, carbon and phosphorus cycles, etc.

Building a common and generalized understanding of the connectedness of these societal challenges offers the best basis for mobilizing the necessary societal dynamic for change in a favourable direction.

# Appendix

## Promising GrowH! intervention approaches

### A1 Introduction

Within the GrowH! project, several tasks were undertaken and combined to learn more about effective childhood obesity prevention. The results are summarized in this appendix.

In the first task, a statistical analysis was conducted to estimate the long-term effects of so-called hypothetical interventions on childhood overweight and obesity based on data from a large-scale European cohort study. Using methods of causal inference, we simulated the effects of behavioural changes, e.g. meeting screen time recommendations, on the risk of developing overweight/obesity. This analysis helped to identify behaviours that have the strongest impact on children's weight development in the long run (see A2.1) and to locate them into the overall system of obesity-related factors (see A2.2). The second task was to implement two different intervention approaches in new contexts that had shown promising effects in other contexts – in other words proof of their feasibility. The first intervention used a family-based, motivational interviewing approach to address families with children aged 3 to 9 years in Bremen, Germany (see A3.1). The second intervention addressed 9- to 11-year old children and used a youth participatory action research approach in Zaragoza, Spain (see A3.2). The aim of the proof of feasibility studies was to learn more about the adaptability and transferability of the intervention approaches to new contexts where particular attention was paid to children considered to grow up under disadvantaged conditions. Both interventions did not use a fully-fledged whole systems approach, but we interpreted the result of their implementation applying a systems lens.

### A2 Hypothetical interventions: what, why and how?

In order to generate evidence for informing the development of successful obesity interventions, it is important to identify the most important health behaviours to be addressed. Based on data of a large European children cohort, we first simulated the long-term effects of behavioural changes on the incidence of overweight and obesity; this is referred to as “hypothetical interventions” in the following (Börnhorst et al. 2023). In a second step, we interpreted the findings within the context of a complex system of obesity-related factors based on the causal loop diagram (CLD) derived by Luna Pinzon et al. (2023); described in detail in Section A2.2. This means we link the most important health behaviours to upstream factors that determine these behaviours. This provides relevant background information that can be integrated when devising systems approaches for obesity interventions.

To project the impact of long-term behavioural changes on the incidence of overweight/obesity (i.e. to estimate hypothetical intervention effects) we used the so-called parametric g-formula which is a method of causal inference (Daniel et al. 2013). The manuscript describing this approach in detail has recently been published (Börnhorst et al. 2023). Based on this methodology ‘what if’ questions can be answered such as:

*“What would happen to the incidence of overweight/obesity if every child ...*

*... adhered to screen time recommendations?"*  
*... adhered to sleep recommendations?"*  
*...used an active form of transport?"*  
*...was a member in a sports club?"*  
*...reduced the intake of sugar-sweetened beverages by 1/day?"*  
*...and so on*

In addition, we determined the effect of changing multiple behaviours simultaneously.

Our analyses were based on data of the multi-centre IDEFICS/I.Family cohort study (Ahrens et al. 2017). The baseline survey took place 2007/08 where 16 229 children aged 2 to 9 years participated from eight European countries (Belgium, Cyprus, Estonia, Germany, Hungary, Italy, Spain, Sweden). The cohort completed its fourth follow-up in 2020/21 and covers a variety of obesity- and lifestyle-related risk factors over a period of 13 years.

## A2.1 Key results

As intervention targets for the hypothetical interventions we focused on seven behaviours that are often addressed in real life interventions:

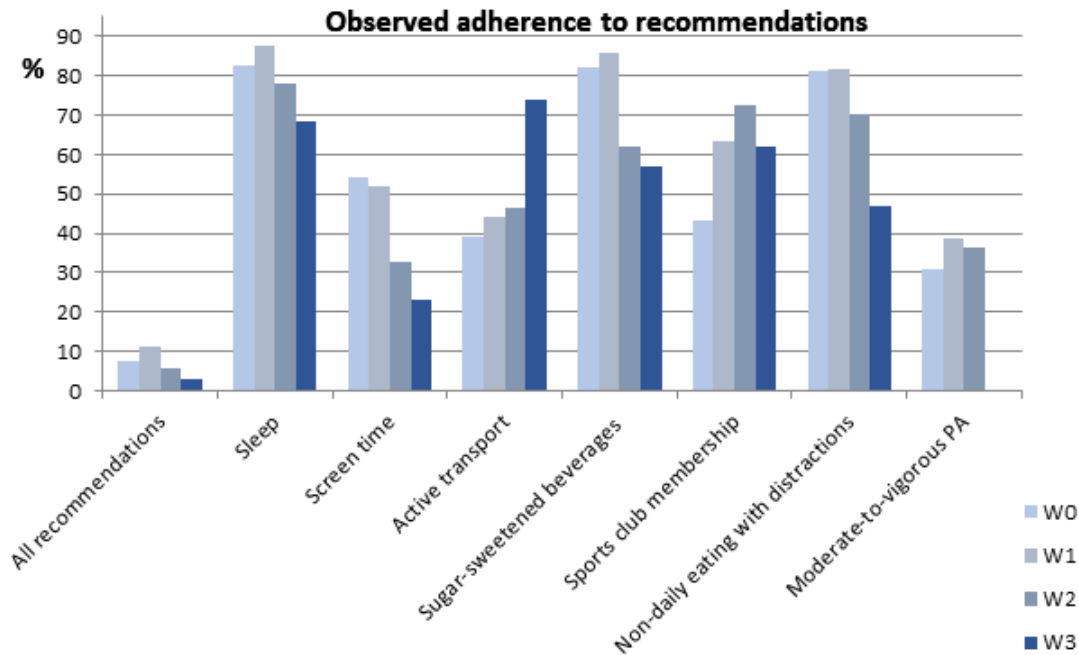
- Nocturnal sleep duration
- Screen time
- Sugar-sweetened beverage consumption
- Eating while doing something else, e.g. watching TV
- Membership in sports club
- Using an active form of transport to/from kindergarten/school/work
- Moderate-to-vigorous physical activity (MVPA; only in a subgroup)

We compared two types of hypothetical behavioural changes:

- Strictly adhering to recommendations (e.g. ‘all children adhere to sleep recommendations’)
- Changing the behavioural factor by a small amount (e.g. ‘all children increase sleep duration by 30 minutes/day’)

Our analysis dataset comprised of 10 877 children participating in the multi-centre IDEFICS/I.Family cohort study that were not overweight or obese at baseline (wave 0).

**Figure A1** shows the observed adherence to the recommendations for the single behavioural factors as well as the percentage of children that adhere to all recommendations by examination wave. While adherence to most behavioural recommendations declined with age, e.g. for sleep (82.5% at wave 0 to 68.4% at wave 3) and screen time (54.1% at wave 0 to 23.2% at wave 3), the percentage of children using an active form of transport to kindergarten/school/work increased with age (39.2% at wave 0 to 73.9% at wave 3). Only few children adhered to all behavioural recommendations.



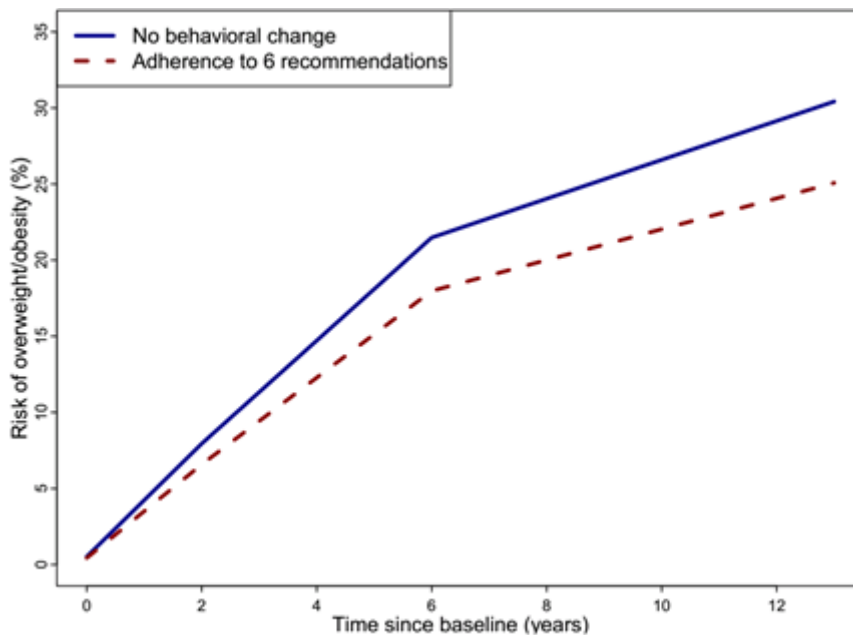
**Figure A1: Percentage of children that adhered to all recommendations as well as to recommendations concerning the single behavioural factors by assessment wave (W0=baseline (2-9 years), W1=1st follow-up wave (4-11 years), W2=2nd follow-up wave (8-14 years), W3=3rd follow-up wave (15-22 years))**

PA: physical activity

We simulated the 13-year risk of developing overweight/obesity when fully adhering to the above intervention targets and compared it to the risk under no behavioural change (i.e. children behaved the way they behaved before). We further calculated the so-called potential impact fractions (PIF) for the behaviour change scenarios. The PIF gives the fractional reduction of overweight/obesity cases that would occur when changing the current behaviour in the population to that specified in the hypothetical scenarios.

The risk of developing overweight/obesity under no behavioural change was estimated to be 30.7% and could be reduced to 25.4% under a joint intervention targeting six behaviours based on health recommendations (**Figure A2**). This means, in a group of 100 children, about 31 children would develop overweight/obesity over a 13-year period without behavioural change and about 25 when adhering to all six behavioural recommendations. This suggests that incidental overweight/obesity could be prevented in about 5 to 6 out of 100 children under a joint behavioural intervention. This corresponds to a relative reduction of the risk of developing overweight/obesity by 17%. It should be noted that these estimates are likely to be underestimated amongst others due to measurement errors in proxy-reported data and should hence be interpreted as the minimal risk reductions that can be achieved based on the described behavioural changes.

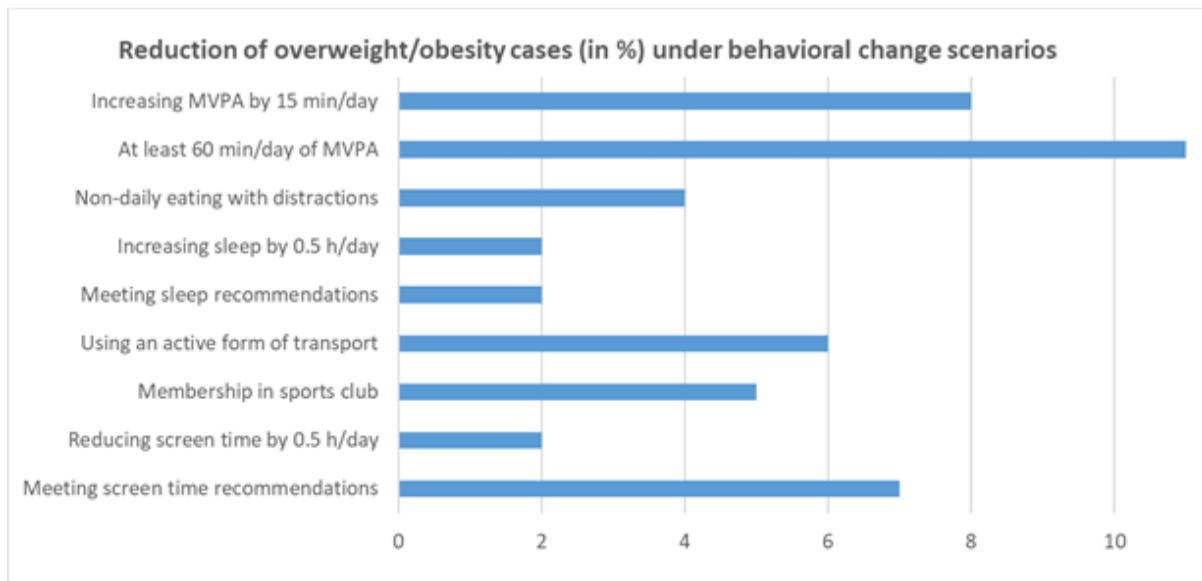




**Figure A2.** Risk of developing overweight or obesity when adhering to six behavioural recommendations (red line) compared to risk under no behavioural changes (blue line). Figure adopted from.<sup>5</sup>

The **most effective single intervention targets** were to **meet screen time (Figure A3)** and **MVPA recommendations**. For instance, complying with the MVPA recommendation alone resulted in a relative reduction of the overweight/obesity risk by 11% over a six-year period. However, these were also the interventions with the highest number of participants intervened on over time (97.1% of the population for screen time, 88.3% for MVPA), i.e. who would need to change their previous behaviour. Almost no child adhered to these recommendations over the entire follow-up period. Sports club membership and ‘non-daily eating while doing something else’ also showed to be promising intervention targets. Adherence to sleep recommendations showed a small favourable effect on the risk of developing overweight/obesity. Active transport only showed a favourable effect when accounting for the distance to kindergarten/ school/ work. Unexpectedly, our results suggest that limiting SSB consumption increases the risk of developing overweight/obesity which may be explained by differential misreporting – a common problem in nutritional epidemiology. Already 15 additional min/day of MVPA and 30 additional min/ day of sleep showed favourable effects on the risk of developing overweight/obesity suggesting that even small behavioural changes can have a beneficial effect.

We further studied whether the most promising intervention targets for children differ by demographic or parental characteristics: The most effective intervention targets in children of parents with low/medium educational level was being member in a sports club; for children of mothers with overweight/obesity, meeting screen time recommendations and membership in a sports club had the largest effects. Meeting screen time recommendations showed larger effects in girls as compared to boys while the opposite was observed for membership in a sports club and ‘non-daily eating while doing something else’. Adherence to screen time recommendations had a larger effect in children aged 2 to <6 years at baseline; being member in a sports club had a larger intervention effect in children aged 6 to <10 years at baseline.

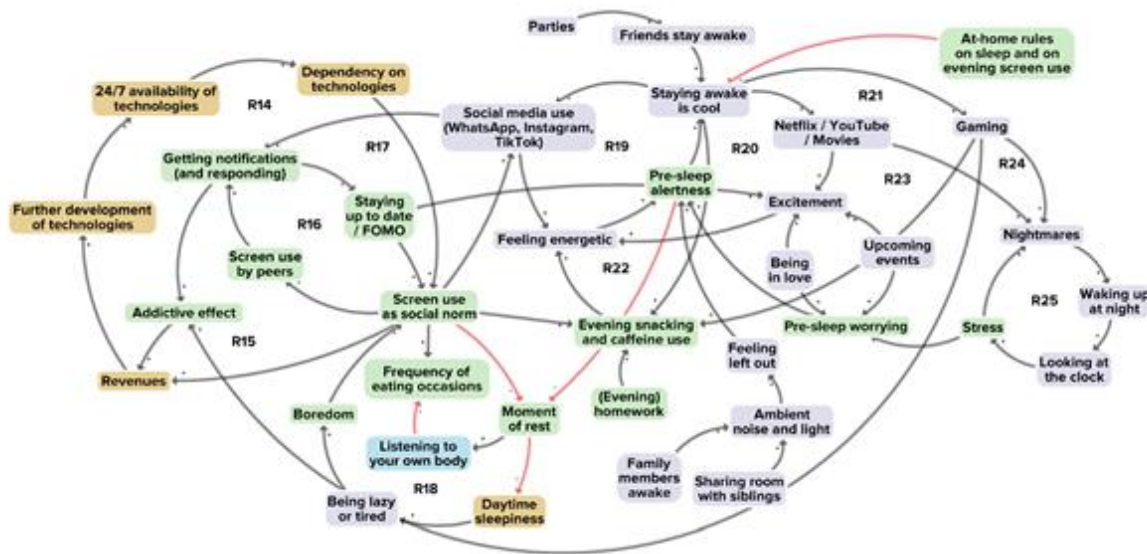


**Figure A3.** Fractional reductions of overweight/obesity cases that would occur when changing the current behaviour in the population to that specified in the hypothetical intervention over a 13-year period. For instance, if all children adhered to screen time recommendations, the number of overweight/obesity cases could be reduced by 7% over a period of 13 years.

## A2.2 Interpreting the findings from a systems lens

Luna Pinzon et al. (2023) developed a CLD to understand the overall system and dynamics of obesity-related behaviours accounting for the perspectives of adolescents, researchers and local stakeholders. We used this CLD to identify important upstream factors of the individual behaviours targeted in the hypothetical interventions (see A2.1) as well as to interpret our findings within the context of this complex system of obesity-related factors. Within the CLD, Luna Pinzon et al. (2023) identified six subsystems out of which three were most relevant in our context. These subsystems included the interactions between (1) adolescents and the physical activity environment, (2) adolescents and the online environment and (3) adolescents, parenting and wider socioeconomic environment.

In the hypothetical interventions, *screen time* turned out to be a promising intervention target for long-term childhood obesity prevention. **Figure A4** shows the subsystem of factors that may determine screen time identified by Luna Pinzon et al. (2023). Multiple factors in the system increase screen time of children and adolescents: Screen use is a social norm in everyday life due to society's dependence on new technologies. This social norm is enhanced by the screen use of peers, exchange of notifications with them and the strong desire to stay up to date. Adolescents often extend the screen use to the evening and night-time hours, particularly, if there are no parental rules on *sleep* and evening screen use. Social media use, watching movies or streaming endless episodes of series and gaming before sleeping can cause stress which impairs the sleep quality and duration among other factors such as ambient noise and light, sharing bedroom with siblings, family members awake, upcoming events, being in love and excitement. The blue and bright light emitted by digital devices appears to affect the circadian rhythm, delaying sleep onset and shortening the overall duration of sleep (Touitou et al. 2016). Our estimations revealed that already 30 min of additional sleep per day has a small favourable effect on overweight/obesity.



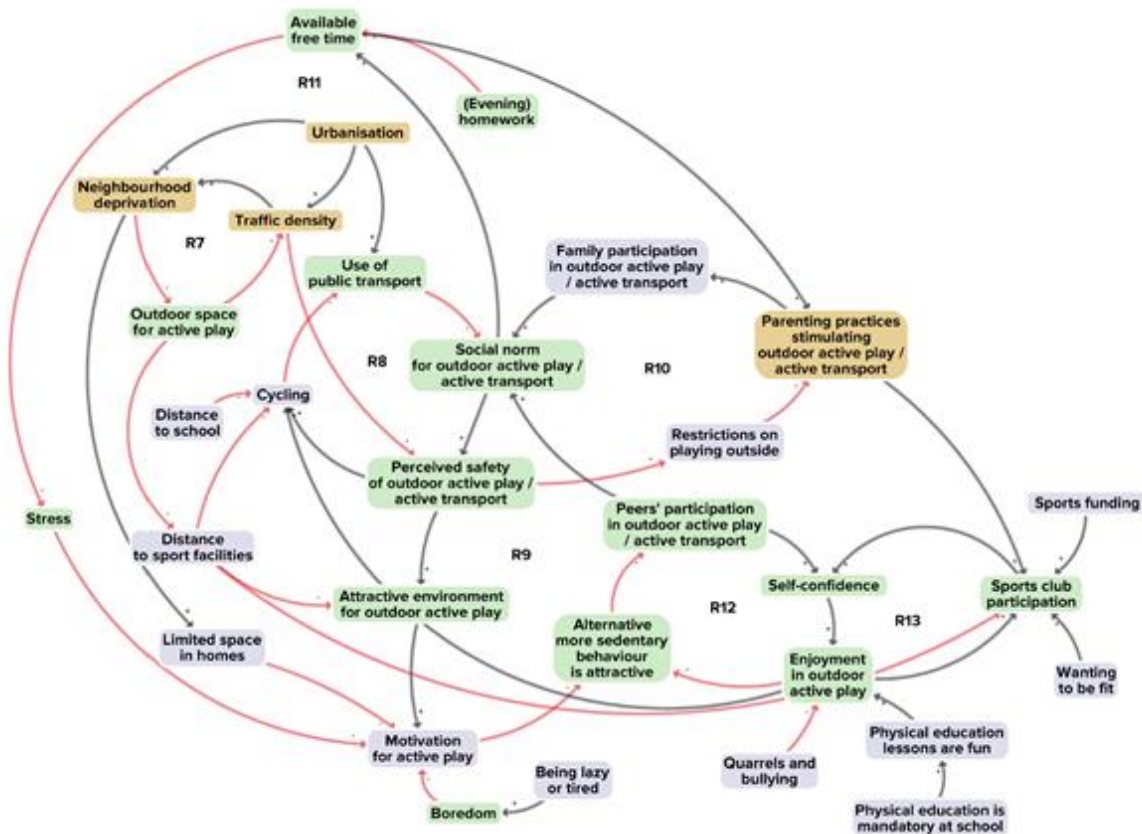
**Figure A4: Interaction between adolescents and the online environment.** Factors derived from the researchers' perspective are shown in yellow, those from the adolescents' perspective in purple, and those from the stakeholders' perspective in blue. Factors present in at least two of the three perspectives are shown in green. Black arrows indicate positive polarity and red arrows indicate negative polarity in the causal relationship between factors

Taken from: Luna Pinzon A, Stronks K, Emke H, van den Eynde E, Altenburg T, Dijkstra SC, Renders CM, Hermans R, Busch V, Chinapaw MJM, Kremers SPJ and Waterlander W (2023) Understanding the system dynamics of obesity-related behaviours in 10- to 14-year-old adolescents in Amsterdam from a multi-actor perspective. *Front. Public Health* 11:1128316. doi: 10.3389/fpubh.2023.1128316

COPYRIGHT © 2023 Luna Pinzon, Stronks, Emke, van den Eynde, Altenburg, Dijkstra, Renders, Hermans, Busch, Chinapaw, Kremers and Waterlander

Another promising intervention target in our hypothetical interventions was achieving the recommendation of at least 60 min/day in MVPA. *Sports club membership* and *active transport* can contribute to attain this daily time in MVPA. Also sports club participation, active transport and outdoor active play are subject to a system of promoting and hindering influences as displayed in the CLD subsystem on the interaction between adolescents and the physical activity environment by Luna Pinzon and co-authors (**Figure A5**). Urbanization is associated with a high building and traffic density which limit the available outdoor space for active play, sport venues and safe walking and cycling routes which in turn increase the distance to sport facilities and can reduce the time they are used or even hinder a sports club membership. Sports club participation also depends on the available household budget and/or available sports funds as well as access to affordable sport facilities. Stimulating parents who value the physical activity of their children can have a promoting effect. Additionally, sports participation can be fostered by the desire of the child/ adolescent to be fit. Enjoyment in outdoor active play which can result from positive experiences during physical education in school and an attractive environment for outdoor play can either promote or hinder a sports club participation. On the other hand, experiencing quarrels and bullying during outdoor active play or demotivating physical education in school reduces the enjoyment in outdoor play. Sports club participation as well as participation of peers in outdoor active play and active transport increase the self-confidence which in turn again enhances enjoyment in outdoor active play. Parents and peers play an important role in this system as they can support the social norm for outdoor active play and active transport by family and peer participation. In contrast, this social norm can be hampered if, for instance, the parents do not have available free time, if there are barriers in parents' logistics regarding sports or if the traffic density reduces the perceived safety of the physical activity

environment. Further, low distances, safe cycling lanes and walking paths, as well as good local transport connections to reach sport facilities are important. Additionally, schools located close by the home are important pre-conditions to promote active commuting (Prince et al. 2022). In case of long distances, children and adolescents use less often modes of active transport, e.g. cycling, and may be taken to school by car or use public transport. Due to a lack of a (perceived) safe environment, parents may not only restrict active transport, but also outdoor play. As a consequence, screen use may become more attractive which in turn reduces the chance to attain sufficient time in MVPA (Luna Pinzon et al. 2023).



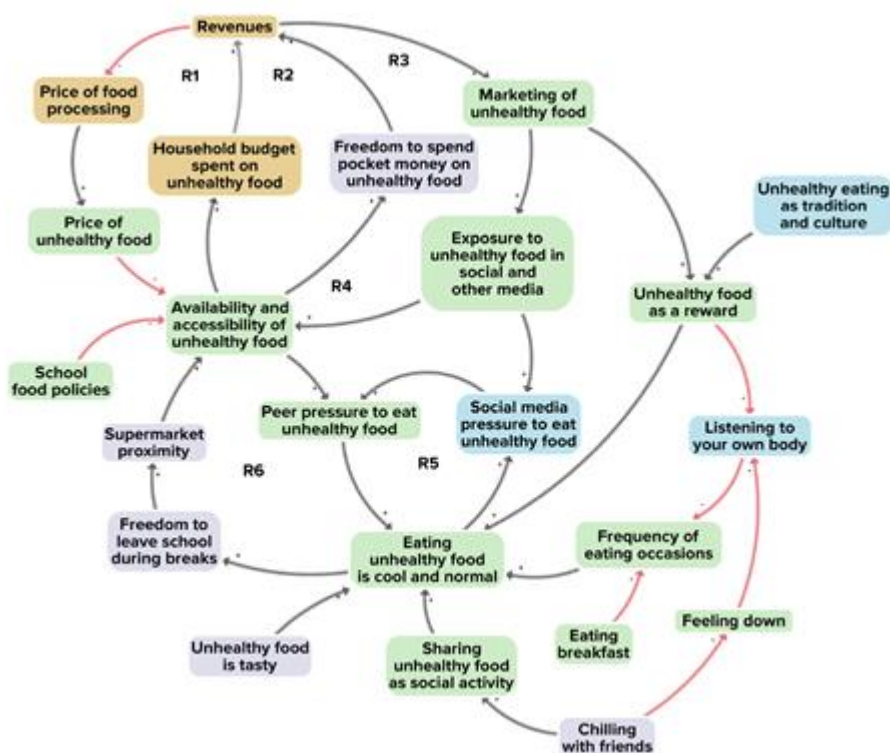
**Figure A5: Interaction between adolescents and the physical activity environment.** Factors derived from the researchers' perspective are shown in yellow, and those from the adolescents' perspective in purple. Factors present in at least two of the three perspectives are shown in green. Black arrows indicate positive polarity and red arrows indicate negative polarity in the causal relationship between factors.

Taken from: Luna Pinzon A, Stronks K, Emke H, van den Eynde E, Altenburg T, Dijkstra SC, Renders CM, Hermans R, Busch V, Chinapaw MJM, Kremers SPJ and Waterlander W (2023) Understanding the system dynamics of obesity-related behaviours in 10- to 14-year-old adolescents in Amsterdam from a multi-actor perspective. *Front. Public Health* 11:1128316. doi: 10.3389/fpubh.2023.1128316

COPYRIGHT © 2023 Luna Pinzon, Stronks, Emke, van den Eynde, Altenburg, Dijkstra, Renders, Hermans, Busch, Chinapaw, Kremers and Waterlander

The hypothetical interventions further revealed that *eating with mealtime distractions* like watching TV increases the risk of developing overweight/obesity. Eating with distractions, so-called mindless eating, may lead to overeating in response to external stimuli ('not listening to Internal hunger and satiety cues'). This can be enhanced when feeling down and using unhealthy food as a reward which in turn can have a negative impact on the frequency of eating occasions as indicated in the subsystem on the interaction of adolescents and the food system (see **Figure A6**; Luna Pinzon et al. 2023). Further, extensive screen time does not only mean excessive sedentary time but also continuous exposure to marketing for unhealthy

foods on television and the internet, and can thus increase the consumption of unhealthy foods. Parents as healthy role models and parental mealtime rules/ shared family meals can help to prevent ‘eating with distractions’. On the other hand, parents can even reinforce this adverse behaviour in their children and adolescents, if they usually eat while watching TV. This behaviour affects a balanced energy account. The same mechanism applies if parents drive their children to school instead of encouraging them to cycle or walk such that the process of conserving energy becomes easier (Butland et al. 2007). The single dietary factor, reducing the consumption of *sugar sweetened beverages*, included in our hypothetical intervention study revealed unexpected results potentially due to socially desirable answer behaviour and corresponding reporting bias and is hence difficult to interpret. However, diet is known to be a main driver of overweight/obesity and **Figure A6** shows that important upstream factors such as marketing of unhealthy food and high accessibility and availability of unhealthy food foster the high preference for unhealthy foods and constrain adolescents from seeking healthier alternatives.



**Figure A6: Interaction between adolescents and the food environment.** Factors derived from the researchers’ perspective are shown in yellow, those from the adolescents’ perspective in purple, and those from the stakeholders’ perspective in blue. Factors present in at least two of the three perspectives are shown in green. Black arrows indicate positive polarity and red arrows indicate negative polarity in the causal relationship between factors.

Taken from: Luna Pinzon A, Stronks K, Emke H, van den Eynde E, Altenburg T, Dijkstra SC, Renders CM, Hermans R, Busch V, Chinapaw MJM, Kremers SPJ and Waterlander W (2023) Understanding the system dynamics of obesity-related behaviours in 10- to 14-year-old adolescents in Amsterdam from a multi-actor perspective. *Front. Public Health* 11:1128316. doi: 10.3389/fpubh.2023.1128316

COPYRIGHT © 2023 Luna Pinzon, Stronks, Emke, van den Eynde, Altenburg, Dijkstra, Renders, Hermans, Busch, Chinapaw, Kremers and Waterlander

Parents and their parenting practices play a crucial role in the system of the discussed interacting health-related behaviours. If parents lack free time or a sufficient household budget, if they have stress and are in a survival mode without headspace for healthy behaviours, if they have a low degree of control over

their children or poor health literacy, healthy behaviours of children and adolescents will be difficult to implement.

Overall, our findings from the hypothetical interventions and integration within the CLD underpin that interventions targeting multiple behaviours are required to approach the risk of overweight/obesity from different angles as single-behaviour interventions only have minor effects.

## A3 Case Studies

### A3.1 Bremen – Using a motivational interviewing approach to engage with families in a disadvantaged neighbourhood

Families are important when approaching obesity prevention from a systems perspective because they are the first places where health-related routines are learned and reinforced, where e.g. taste preferences and eating behaviours are shaped (Barnes et al. 2020; Hebestreit et al. 2017; Jilani et al. 2017). During family meals, parents create food environments for children’s early experiences with food variety, taste sensations and healthy choices (Hebestreit et al. 2017; Jilani et al. 2017). From a systems perspective, families can be understood as open adaptive systems that are in constant exchange with the environment but follow their internal logic determined by their interaction pattern (Henry et al. 2015). Equifinality, i.e. the ability of a family to reach a goal through various ways, is one of the key concepts of family systems theory (Whitchurch & Constantine 1993).

There are both challenges and opportunities when engaging with families to create and maintain healthy routines and environments. On the one hand, almost all parents want their children to thrive in a healthy way and want to be ‘good parents’ (Koivumäki & Jallinoia 2023). On the other hand, family life with young children is a busy and often challenging episode in life, as families need to balance and negotiate the demands of other subsystems such as the workplace or childcare. This makes it difficult for parents to invest the energy that is needed to withstand and counteract the many factors in the obesogenic environment they are surrounded by. Therefore, while acknowledging the critical role of families, many approaches to childhood obesity prevention find it difficult to engage with families, and those families who engage are often not the ones most in need (Summerbell et al. 2012; Steenbock et al. 2019).

In this case study, a family-based intervention was implemented for families with children aged 3 to 9 years. Following the principle of *proportionate universalism* (providing more to those with higher needs (Carey et al. 2015)), this program was offered in socially deprived and culturally diverse neighbourhoods instead of targeting families based on sociodemographic characteristics, which can have a stigmatizing effect.

**Table 1. Characteristics of the intervention approach in Bremen.**

<b>Target group</b>	Families with children aged 3-9 years
<b>Setting</b>	Socially deprived and culturally diverse neighbourhood
<b>Intervention components</b>	<ul style="list-style-type: none"> <li>– Four home visits (approx. 60 min per visit) over 4-6 months</li> <li>– Counselling technique: motivational interviewing</li> </ul>

	<ul style="list-style-type: none"> <li>– Written information material in easy-to-understand language</li> <li>– Behaviour change incentives</li> </ul>
<b>Staff</b>	Professional health educators trained in motivational interviewing

### ***Adaptation of the approach***

The program was originally developed and tested in the North American context and had shown promising effects (O’Kane et al. 2018, 2019). The differences in, for example, the built environment, the food environment, social norms and sociodemographic make-up of the families necessitates an adaptation phase to achieve a good intervention-context fit (Moore et al. 2021). The first step in this process was the liaison with an operational stakeholder (Landesvereinigung für Gesundheit und Akademie für Sozialmedizin Niedersachsen Bremen; LVG&AFS) who had the capacity to conduct the program and potentially maintain it after the end of the funding period. Selecting appropriate staff and training them in the main intervention technique (motivational interviewing; MI) was another step in the adaptation process. It proved to be an advantage for the implementation that MI is already an established counselling technique and that many countries have training opportunities. As a counselling technique, MI speaks to the intrinsic motivations of family members and identifies topics and goals in a collaborative manner (Ozer & Piatt 2017; Resnicow & McMaster 2012). In general, MI is a very flexible method that adapts to the motivations and barriers within a family instead of providing expert advice. In this family-based program, the method was combined with written material which offered a structured choice of setting goals for changing family routines related to childhood obesity (e.g., physical activity, sleep, screen time, fruit and vegetable intake).

For the purpose of adapting the program, the original program materials were translated and local information, e.g., regarding where to find additional support in the neighbourhood, was collated. Several group discussions were held with stakeholders and families to discuss the components and the contents of the program. This led to a couple of changes concerning the surface structure of the program (appearance of the material and wording), but also some suggestions for the basic structure of the program were made. For example, a suggestion was taken up to offer alternative locations for the visits if a family was not comfortable being visited at home.

### **Summary of findings**

Trust and language abilities emerged as the overarching and interrelated themes during the feasibility trial, in which 23 families joined the program. Contacting the families worked best when a trusted person from the community introduced the health educator to the families. Word-of-mouth among the families also played an important role. Reports from stakeholders indicated a relevant degree of mistrust among families toward public authorities. Being visited at home seemed suspicious to families, especially if they had been in contact with the child protection service. From a systems perspective, this issue supports the notion that not only power and leadership are important features of systems but also the availability of trust (Stansfield et al. 2020). Mapping the stakeholders and discussing with them about the right place for this intervention within the service landscape for a sustainable implementation pointed to a potential trade-off. Integrating the intervention into the portfolio of the public child and youth health service could be an effective way to enable long-term, scalable implementation, while implementation by local actors in the neighbourhood could strengthen trust in the intervention.

Language abilities played a role both in contacting the families and delivering the program. It was an important learning process to find the right words to explain the purpose and the benefits of the program to families with low language skills in German. In 18 out of 23 families that engaged in the program the main language spoken at home was not German. While the participating families were highly satisfied with the program and provided accounts of how the program helped them attain small changes in their family life, it was a challenge for the health educators to let the families take the lead during the conversations as required by MI as a counselling technique. In summary, finding the appropriate language and means to communicate in a meaningful way is an important systems prerequisite for shifting power from the experts to the population and establishing a truly participatory approach.

Two other aspects that are relevant from a systems perspective emerged from the discussions with the stakeholders and health educators. While the coherence of actions to tackle childhood overweight/obesity within systems is important, the stakeholders stressed that having a variety of actions or health offers in the system among which families can choose according to their preference is also an important feature. This alludes to the notion that redundancies in systems added to their resilience, which is of higher value than their efficiency. Another aspect mentioned by the health educators was the scaffolding that was required for connecting families to other services, e.g., sports clubs. This entails not only a good overview of the available services but also establishing personal contacts to create a trustful environment.

### A3.2 Zaragoza – Using Youth-centred Participatory Action Research to develop, implement and evaluate interventions in collaboration with children from a socially disadvantaged and culturally diverse neighbourhood

Through Youth-centred Participatory Action Research (PAR), children actively collaborate as co-researchers with academic researchers to identify issues in their community and initiate actions to address these issues (Morrell et al. 2008; Ozer & Piatt 2017). As children are experts of their own lives, they can provide valuable insights that might lead to 1) a better understanding of how they perceive an issue and the factors driving this issue, and 2) interventions (addressing the issue) that meet children's needs and wishes. Considering that current interventions have been unsuccessful in decreasing health inequalities (Hilier-Brown et al. 2014), collaborating with children through YPAR might especially be key for children from low socioeconomic position (Anyon et al. 2018; Frerichs et al. 2016; Shamrova & Cummings 2017).

In the case study “Chic@s en Acción Zaragoza: Creciendo Sanos!” academic researchers collaborated with 9-11-year-old co-researchers attending primary school in a socially disadvantaged and culturally diverse neighbourhood in Zaragoza, Spain, applying YPAR (Camarota & Fine 2008) combined with Intervention Mapping, i.e. a structural stepwise protocol for identifying behavioural determinants and evidence-based strategies. This approach was originally applied in Amsterdam, the Netherlands, in the ‘Kids in Action’ study (Abraczinskas & Zarrett 2020; Anselma et al. 2019; Anselma et al. 2020; Kemmis & McTaggart 2005). In so-called Action Teams, 6-8 children worked together with a facilitating researcher to identify the needs of 9-11-year-old children (in terms of perceived health, health behaviours, and the role of the environment with respect to their health and health behaviours) (phase 1), and to co-develop, implement and evaluate interventions (or ‘actions’) addressing these needs (phase 2). Through peer-research, the Action Teams explored the needs and wishes of their peers. Subsequently, based on a shared



understanding of children’s needs, the Action Teams developed actions addressing their needs. The academic facilitator supported the Action Teams by sharing knowledge on evidence-based strategies. Relevant stakeholders supported the development and implementation of actions.

Table 2.2. Characteristics of the intervention approach in Zaragoza

Target group	Children aged 9-11 years attending primary school (grades 4 and 5)
Setting	A socially disadvantaged and culturally diverse neighbourhood
Intervention components	The Action Teams co-created and implemented the following actions: <ul style="list-style-type: none"> <li>● Cooking workshop</li> <li>● Olympic sports day</li> </ul>
Staff	<ul style="list-style-type: none"> <li>● Local government (public health and education areas) of Zaragoza supported in the recruitment of schools</li> <li>● An academic researcher facilitated meetings with the Action Teams</li> <li>● Local stakeholders (social workers and sports from the municipality, private foundation to promote healthy growth in the municipality, national supermarket chain, civic centres in the neighbourhood and teachers and directors from selected schools) implemented the co-created intervention components.</li> </ul>

### *Adaptation of the approach*

Before implementing the “Kids in Action” approach in Zaragoza, Spain, the YPAR process was adapted to fit the local context and to include the latest research evidence. We adapted the process across its phases, adhering to YPAR principles while making adjustments based on context, stakeholder needs, previous lessons learned and ongoing reflections. These adaptations were focused on enhancing stakeholder engagement and facilitated the co-development of intervention actions within the chosen neighbourhood. Adaptation included additional recruitment methods, such as a recruitment video that was distributed through schools. Moreover, a systems lens was applied including the mapping of relevant (local) stakeholders and assets in the neighbourhood and the development of ‘Causal Loop Diagrams’ (CLDs) to visualize children’s perceptions of drivers of unhealthy behaviours (i.e. lack of physical activity, unhealthy dietary behaviours, insufficient sleep). Additionally, the evaluation approach was adapted by applying a delayed baseline measurement approach.

### *Findings from the feasibility study: process and effect evaluation*

The feasibility trial in Zaragoza included 3 Action Teams at 2 schools in Las Fuentes, including in total 20 children (13 children started in grade 4 and 7 in grade 5). Of these 20 children, 16 children (80%) participated in both phases of the YPAR approach. A total of 48 children from school 1 and 50 children from school 2 were contacted to request their participation. Eighty children participated in the actions that were implemented (32 children in one school and 48 children in the other school; 59% response). In

total, 20 Action Team meetings were held for the participatory needs assessment, and 39 meetings for the action development and implementation phase. In general, the YPAR approach was implemented as planned, with small adaptations with respect to the number of meetings needed to achieve the planned goals. Allowing flexibility e.g. in planning sessions is part of the nature of PAR, to ensure that meetings are fun and aligned with children's needs and desires.

Testing the feasibility included evaluating the process and outcomes of the transfer of the Kids in Action study from Amsterdam, the Netherlands, to Zaragoza, Spain. We organized focus group interviews with 1) Action Team children (two times, one per school year); 2) children participating in implemented actions (one focus group after action implementation); and 3) involved stakeholders (one school director and two teachers (one from each school)). Additionally, a child-report questionnaire was used to assess children's health behaviours and its determinants, using validated items from other questionnaires where available, including for example items related to being alone at home, water consumption, time spent playing outside, sleep practices, and self-rated health. Children filled in the questionnaire in the classroom during school hours, in the presence of an academic researcher who explained the procedure of completing the questionnaire before the questionnaires were handed out. The children needed approximately 40 min to complete the questionnaire. Almost all participating children (i.e. 96%; n=77) completed the questionnaire.

The children who participated in the action teams felt that they were listened to by adults. At the end of the project, children learned to critically analyse a situation and gained knowledge about healthy behaviours. Children indicated that their communication skills improved during the YPAR approach, mainly for active listening, mutual understanding of their peers and open communication. Furthermore, children's felt that their self-confidence was increased as well as their public speaking skills to share their opinions with others. These effects were mostly perceived by children in grade 5 compared to grade 4 children. Children in the Action Teams developed and implemented a cooking workshop and Olympic sports day at one school and an Olympic sports day at the other school, which were implemented at the schools with the support of school staff, and some materials from municipal sports places, supermarkets chain and foundation closely related with the neighbourhood. Children in the Action Teams enjoyed the preparation and implementation as they were proud to share their co-created activities with their peers.

#### *Findings from the feasibility study: a systems perspective*

The participatory nature of the approach allowed for continuous adaptation throughout the project, allowing the researchers to adapt the process to the needs and wishes of the children and the school schedule. By involving a systems lens, we gained a more comprehensive understanding of the local system. The stakeholder mapping ensured liaison with relevant community stakeholders, who could support in the identification of key drivers of childhood overweight/obesity, and the development and implementation of actions addressing them. The neighbourhood asset mapping allowed us to get insight into the neighbourhood's resources, strengths, and limitations, to be taken into account when developing and implementing interventions. Finally, the CLDs developed by children and community stakeholders provided valuable insights in their different perspectives on the drivers of childhood overweight/obesity, consequently leading to a more inclusive and nuanced understanding. The main driver observed by children and other stakeholders was "stay alone at home": parental work obligations result in children staying at home alone, and not being able e.g. to participate in afterschool sports/play activities, prepare a mid-afternoon snack, cook dinner, or support children in their sleep routine (e.g. set bedtime). The well-

established social-health network in the neighbourhood (including stakeholders from health care centres, social workers and civic centres from the municipality, schools and foundation closely related with the neighbourhood) provides a great opportunity re-shape the co-created interventions into more thorough and sustainable interventions, and to scale up the YPAR approach.

**Key messages case studies**

- The social-health network in the neighbourhood provides a great opportunity to address the most important health behaviours. The systems approach could be useful in supporting families to engage in healthy behaviours through a simple process.
- The factors driving children's health behaviours reflect different systems levels, e.g. parental rules and family time, physical activity facilities and likelihood of unhealthy food.

## References for the Appendix

- Abraczinskas M, Zarrett N. Youth Participatory Action Research for Health Equity: Increasing Youth Empowerment and Decreasing Physical Activity Access Inequities in Under-resourced Programs and Schools. *Am J Community Psychol* 2020;66(3-4):232-43.
- Ahrens W, Siani A, Adan R et al. Cohort Profile: The transition from childhood to adolescence in European children-how I.Family extends the IDEFICS cohort. *Int J Epidemiol* 2017;46(5): 1394-1395j.
- Anselma M, Altenburg T, Chinapaw M. Kids in Action: the protocol of a Youth Participatory Action Research project to promote physical activity and dietary behaviour. *BMJ Open* 2019;9(3):e025584.
- Anselma M, Chinapaw M, Altenburg T. "Not Only Adults Can Make Good Decisions, We as Children Can Do That as Well" Evaluating the Process of the Youth-Led Participatory Action Research 'Kids in Action'. *Int J Env Res Pub Health* 2020;17(2):625.
- Barnes MD, Hanson CL, Novilla LB, et al. Family-Centered Health Promotion: Perspectives for Engaging Families and Achieving Better Health Outcomes. *Inquiry*. 2020;57:46958020923537
- Börnhorst C, Pigeot I, De Henauw S et al. The effects of hypothetical behavioral interventions on the 13-year incidence of overweight/obesity in children and adolescents. *Int J Behav Nutr Phys Act* 2023; 20(1):100.
- Butland B, Jebb S, Kopelmann P et al. Tackling obesities: Future Choices - Project Report. In: Skills. DoIJa, (ed). UK, 2007.
- Cammarota J, Fine M. In: Cammarota J, Fine M, editors. Youth Participatory Action Research: A Pedagogy for Transformational Resistance, in Revolutionizing education: youth participatory action research in motion. New York: Routledge 2008;p 1–11.
- Carey G, Crammond B, De Leeuw E. Towards health equity: a framework for the application of proportionate universalism. *Int J Equity Health*. 2015;14:81.
- Daniel RM, Cousens SN, De Stavola BL et al. Methods for dealing with time-dependent confounding. *Stat Med* 2013;32(9):1584-618.
- Frerichs, L.; Ataga, O.; Corbie-Smith, G.; Lindau, T.S. Child and youth participatory interventions for addressing lifestyle-related childhood obesity: A systematic review. *Obes Rev* 2016;17:1276–1286.
- Anyon, Y.; Bender, K.; Kennedy, H.; Dechants, J. A Systematic Review of Youth Participatory Action Research (YPAR) in the United States: Methodologies, Youth Outcomes, and Future Directions. *Health Educ Behav* 2018;45, 865–878.
- Henry CS, Sheffield Morris A, Harrist AW. Family Resilience: Moving into the Third Wave. *Family Relations* 2015;64(1):22-43.
- Jilani HS, Intemann T, Bogl LH et al. Familial aggregation and socio-demographic correlates of taste preferences in European children. *BMC Nutrition* 2017;3(1):87.
- Hebestreit A, Intemann T, Siani A, et al. Dietary Patterns of European Children and Their Parents in Association with Family Food Environment: Results from the I.Family Study. *Nutrients* 2017;9(2):126.
- Hillier-Brown, F C, Bambra, C L, Cairns J M et al. Systematic review of the effectiveness of individual, community and societal level interventions at reducing socioeconomic inequalities in obesity amongst children. *BMC Public Health* 2014, 14, 834.
- Kemmis S, McTaggart R. Participatory Action Research: Communicative Action and the Public Sphere. In: Denzin N., Lincoln Y., editors. *The Sage Handbook of Qualitative Research*. Thousand Oaks: Sage; 2005;p 559-603.
- Koivumäki T, Jallinoja P. The good, the bad, and the blameless in parenting: a thematic analysis of discussions of childhood obesity on an internet forum. *BMC Public Health* 2023;23(1):452.
- Luna Pinzon A, Stronks K, Emke H et al. Understanding the system dynamics of obesity-related behaviours in 10- to 14-year-old adolescents in Amsterdam from a multi-actor perspective. *Front Publ Health* 2023;11:1128316.
- Moore G, Campbell M, Copeland L et al. Adapting interventions to new contexts—the ADAPT guidance. *BMJ*. 2021;374:n1679.

- Rollnick S, Butler CC, Kinnersley P et al. Motivational interviewing. *BMJ*. 2010;340:c1900.
- Morrell, E. Six Summers of YPAR: Learning, Action, and Change in Urban Education. In *Revolutionizing Education: Youth Participatory Action Research in Motion*; Cammarota, J., Fine, M., Eds.; Routledge: New York, NY, USA, 2008.
- O'Kane C, Wallace A, Wilson L, et al. Family-Based Obesity Prevention: Perceptions of Canadian Parents of Preschool-Age Children. *Can J Diet Pract Res* 2018;79(1):13-7.
- O'Kane C, Irwin JD, Morrow D et al. Motivational interviewing with families in the home environment. *Patient Educ Couns* 2019;102(11):2073-80.
- Ozer, E.J.; Piatt, A.A. Adolescent Participation in Research: Innovation, rationale and next steps, in *Innocenti Research Briefs 2017*, UNICEF Office of Research. Available online: [https://www.unicef-irc.org/publications/pdf/IRB\\_2017\\_07\\_Adol05.pdf](https://www.unicef-irc.org/publications/pdf/IRB_2017_07_Adol05.pdf) (accessed on 26 October 2019).
- Prince SA, Lancione S, Lang JJ et al. Examining the state, quality and strength of the evidence in the research on built environments and physical activity among children and youth: An overview of reviews from high income countries. *Health Place* 2022;76:102828.
- Resnicow K, McMaster F. Motivational Interviewing: moving from why to how with autonomy support. *Int J Behav Nutr Phys Act* 2012;9(1):19.
- Shamrova, D.P.; Cummings, C.E. Participatory action research (PAR) with children and youth: An integrative review of methodology and PAR outcomes for participants, organizations, and communities. *Child. Youth Serv. Rev* 2017;81:400–412.
- Stansfield J, South J, Mapplethorpe T. What are the elements of a whole system approach to community-centred public health? A qualitative study with public health leaders in England's local authority areas. *BMJ Open*. 2020;10(8):e036044.
- Steenbock B, Buck C, Zeeb H et al. Impact of the intervention program “JolinchenKids – fit and healthy in daycare” on energy balance related-behaviors: results of a cluster controlled trial. *BMC Pediatrics* 2019;19(1):432.
- Summerbell CD, Moore HJ, Vögele C et al. Evidence-based recommendations for the development of obesity prevention programs targeted at preschool children. *Obes Rev* 2012;13(Suppl 1):129-32.
- Touitou Y, Touitou D, Reinberg A. Disruption of adolescents' circadian clock: The vicious circle of media use, exposure to light at night, sleep loss and risk behaviors. *J Physiol-Paris* 2016;110(4):467-479.
- Whitchurch G, Constantine L. Systems theory. In: Boss P, Doherty W, LaRossa R, Schumm WS, SK, editors. *Sourcebook on family theories and methods: A contextual approach*. New York, NY: Plenum Press; 1993.

The GrowH! project was funded by the Joint Programming Initiative “A Healthy Diet for a Healthy Life” (JPI HDHL), a research and innovation initiative of EU member states and associated countries.

With the support of the local funding agencies:

Belgium: Research Foundation – Flanders (FWO); Germany: Federal Ministry of Education and Research (BMBF); Spain: Spanish State Research Agency (AEI); The Netherlands: The Netherlands Organisation for Health Research and Development (ZonMw)."

