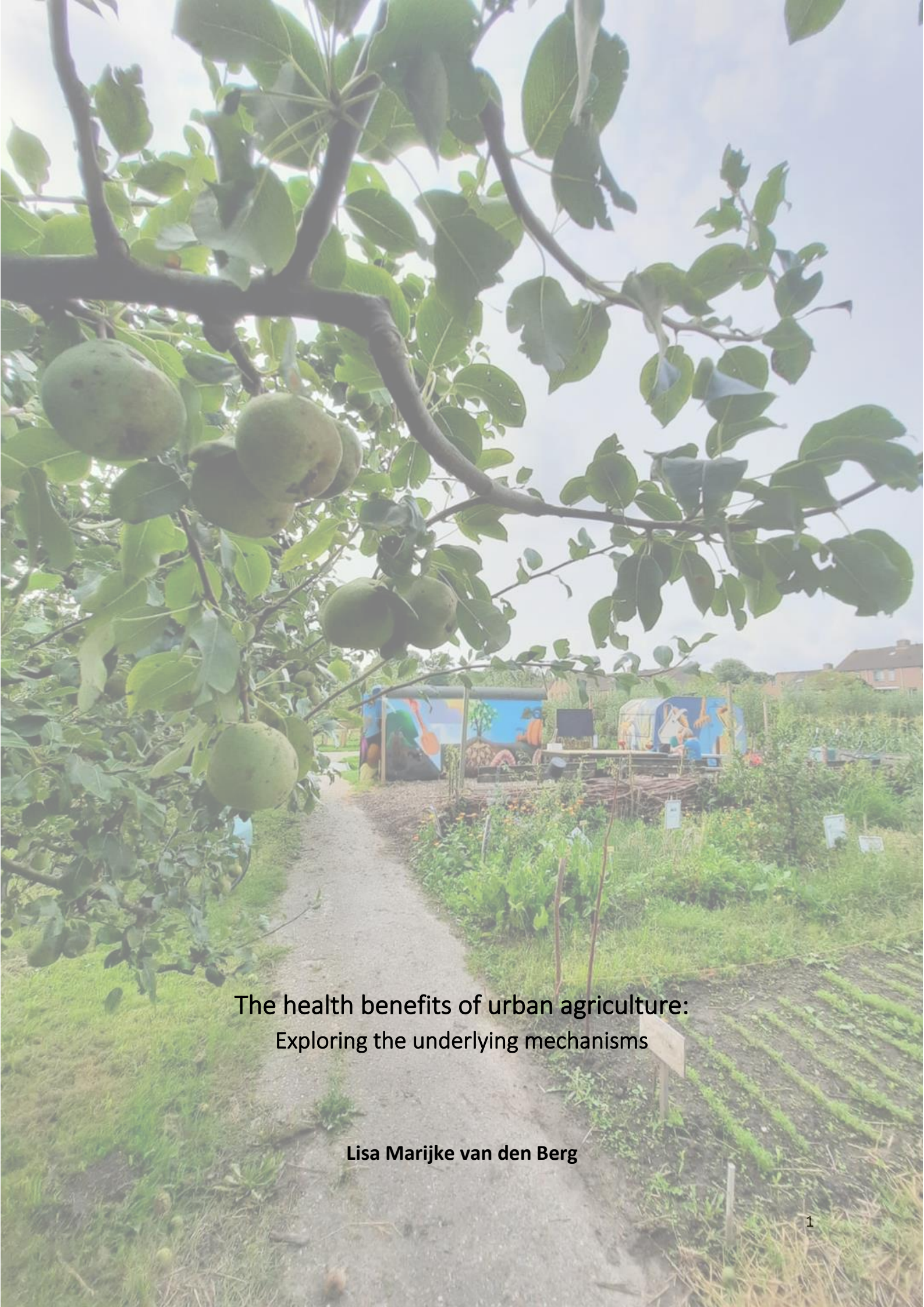

The health benefits of urban agriculture:
Exploring the underlying mechanisms

Lisa Marijke van den Berg

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Supervisors: Lenneke Vaandrager (HSO) and Esther Veen (RSO)

Examiners: Han Wiskerke (RSO) and Lenneke Vaandrager (HSO)

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Preface

The aims of the EFUA, to increase understanding and awareness about urban agriculture by supporting a European agenda about this topic formed the starting point for my thesis. Within the broad spectrum of research directions on benefits obtained by urban agriculture, I chose to focus on the health benefits of urban agriculture. As a student combining the master Communication, Health and Life Science with the master Organic Agriculture at Wageningen University, this thesis brought agriculture and health together. My motivation to start the master combination that I am doing, was to work towards health promoting food systems. This goal became more tangible while working on this master thesis.

There are many people that I would like to thank for their support during the last eight months. First of all, Esther Veen and Lenneke Vaandrager, who supervised and guided me in (parts) of the thesis process and provided me with feedback and advise. Secondly, I would like to thank al participants of urban agriculture initiatives throughout the Netherlands who warmly welcomed me for the interviews. They provided me with new insights, not merely for my thesis, but also in the broader context of the master's degrees I am pursuing. The fieldwork phase in which participants showed me around in their projects were inspiring and gave me even more motivation to work on and finish this thesis in the last stage. Lastly, I would like to thank my family, friends and housemates for their patience, support and feedback during the thesis process.

Abstract

Over the years the interest in the health promotion potential of urban agriculture has been increasing. However, the mechanisms underlying the health benefits of urban agriculture are not known yet, as both health and urban agriculture are broad concepts. As part of the European Forum for a Comprehensive Vision on Urban Agriculture (EFUA) this thesis aimed to get insight into these underlying mechanisms to unlock the potential of urban agriculture in Europe. On top of that, this thesis aimed to provide a visual overview of the underlying mechanisms to support decision making processes and initiators of urban agricultural initiatives.

Methods

By conducting a systematic literature review, the mechanism underlying the health benefits of urban agriculture were explored. The health outcomes described in the literature review were divided into the categories 'mental health', 'social health' and 'physical health'. These mechanisms divided and elaborated upon in the categories 'lifestyle', 'community' 'empowerment' and 'green'. This led to the development of a conceptual framework. Nine semi-structure interviews took place among participants in urban agriculture to validate the conceptual framework. The interviewed participants were participating in multiple types of urban agriculture across the Netherlands. The interviews were transcribed and coded using Atlas.ti. The conceptual framework was redesigned based on the outcomes of the interviews.

Results

The mechanisms underlying the health benefits of urban agriculture that were identified, were described to a varying extent per type of urban agriculture. Overall, it can be concluded that rooftop farming and vertical farming were less often focus of research than other types of urban agriculture. Four categories of underlying mechanisms were identified in the literature. Health benefits gained through urban agriculture were identified, acknowledging the fact that urban agriculture is part of urban green., health benefits gained through urban agriculture were identified, acknowledging the fact that urban agriculture is part of urban green. However, not all urban green consists of urban agriculture. Therefore, only the mechanisms that were considered relevant for urban agriculture according to the literature were included. This led to the underlying mechanisms in the category 'green' being: exposure to green, mitigation of climate change and neighbourhood aesthetics.

Through these underlying mechanisms benefits were described in the literature for all three health outcomes. The underlying mechanisms described with the category 'lifestyle' were: physical activity and fruit & vegetable (F&V) consumption. These underlying mechanisms mostly supported physical health, but also mental health by stress reduction through perceived increase of food security. In the category 'community' the identified mechanisms underlying the health benefits of urban agriculture were: social support and sense of community. These underlying mechanisms in the category 'community' support mental and social health according to the literature. The category 'empowerment' contains: knowledge & skills, personal development and income as underlying mechanisms explaining the health benefits of urban agriculture. According to the literature these mechanisms support all three types of health benefits.

Besides the underlying mechanisms, factors were identified and described in the literature that influence the underlying mechanisms and thereby the health outcomes. These factors of influence were captured in 'participation level', 'specific target groups' and 'passive vs active use'. 'Participation level' reflects the impact of the participation level in an urban agriculture initiative on the health benefits derived from this. 'Specific target groups' refers to the different groups targeted

by certain urban agricultural initiatives. For these specific target groups, certain underlying mechanisms were of a greater importance compared to the general public described in the dominant literature. 'Passive vs active use' was identified as a factor of influence on the underlying mechanisms because the type of participation (passive or active) in urban agriculture determines health benefits derived from urban agriculture.

Overall, the participants validated the content of framework and recognized the underlying mechanisms and outcomes visualized. The categorization, as well as the underlying mechanisms were recognized and elaborated upon by the participants. Nevertheless, the design of the framework received criticism by the participants as being unappealing and insufficiently meeting the needs of urban agriculture participants.

Discussion

The results from the interviews led to a redesign of the conceptual framework. This resulted in a round shaped framework with a more holistic view on health, by letting go of the different categories of health and underlying mechanisms. Nevertheless, all validated content was incorporated into the framework and the content of the framework remained the same as before. This thesis showed that visualisation of results should be adjusted to the target audience

By increasing the useability of the framework for participant in urban agriculture, the framework allows for bottom-up advocacy. Nevertheless, validation and usability of the framework for other relevant stakeholders, such as researchers and policy makers, was not investigated in this thesis. The results of this thesis suggest that visualisation of research outcomes might be more effective in communication when directed at the audience. Future research is recommended to look into the usability of the framework for research and policy purposes, whilst guiding research for development of guidelines for visualisation of scientific outcomes.

Conclusion

In conclusion, the mechanisms underlying the health benefits of urban agriculture were investigated in this thesis. Physical activity, F&V consumption, social support and sense of community, education, knowledge & skills, income, exposure to green, climate mitigation and neighbourhood aesthetics were identified as mechanisms underlying the health benefits of urban agriculture. These underlying mechanisms were divided into four mechanisms categories being lifestyle, community, empowerment and green. This resulted in a conceptual framework which was content-wise validated with semi-structured interviews. Nevertheless, a redesign of the framework was made to increase usability for participants of urban agriculture for the framework allowing bottom-up advocacy. With these outcomes, this thesis helps to unravel the potential of urban agriculture by providing a starting point for understanding and visualizing the health benefits of urban agriculture.

Keywords: Urban agriculture |public health| physical health | mental health | social health|

Word count: 17.569

Table of content

List of abbreviations

Common Agricultural Policy	CAP
European Forum on Urban Agriculture	EFUA
European Parliamentary Research Service	EPRS
European Union	EU
Fruit and vegetable	F&V
Haemoglobin A1c	HgA1c
United Nations	UN
World health organisation	WHO

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Chapter 1: Introduction

1. Introduction

Urban agriculture practices and research is of increasing interest in the field of public health (Audate et al. 2018). According to the literature, urban agriculture-related activities have a positive impact on physical and mental health outcomes (e.g., Brown & Jameton, 2000). Additionally, the literature reports numerous beneficial impacts of urban agriculture (Audate et al. 2019).

However, urban agriculture captures a broad categorization of agricultural activities related to the city, but there is a variation concerning scale, location, activities, and goals (Veen 2015). Urban agriculture can be described as a form of agriculture that uses land located in the urban area. By way of contrast, others describe it as any form of agricultural activity that is carried out in the urban and peri-urban areas (Viljoen and Bohn 2014). Therefore, the literature about the health benefits of urban agriculture is scattered over different types of urban agriculture and a broad range of possible health benefits.

To capture the diverse characteristics of urban agriculture a typology is currently under development by the European Forum on Urban Agriculture (EFUA), to which this thesis is related. The challenge is to increase integration of urban agriculture in European policy and practice, as urban agriculture currently falls between different policy areas (EFUA 2020). It might be not agricultural enough to get support for the conventional oriented Common Agricultural Policy (CAP) or it might not be rural enough to get support from the rural development programs (European Parliamentary Research Service (EPRS) , 2017).

Figure 1 On-site impression of urban agriculture initiative

The lack of integration of urban agriculture in European policy and practice might hamper development of urban agriculture projects in the future, despite the described benefits in literature (EPRS, 2017). Hence, the EFUA aims to increase knowledge and awareness about the possible contribution of urban agriculture to the 2030 Agenda for Sustainable Development of the United Nations (UN).

Next to the agricultural policy challenges, health policy challenges are also related to urban agriculture. Currently, the relation between urban agriculture and health is seen as a promising strategy for health promotion (Alaimo, Beavers, et al. 2016). Community gardens, for example, provide benefits to residents that exceed costs on a societal level, by providing ecosystem services, a place for social interaction and a place for relaxation (Dubová and Macháč 2019). From a health promotion perspective, urban agriculture can be seen as a multicomponent behaviour based socio-environmental practice (Alaimo, Beavers, et al. 2016). However, the health benefits of urban agriculture depend on the goals and objectives of different urban agriculture projects (Kirby et al. 2021). Therefore, awareness among city planners and health policy makers of different effects by project type and by characteristics of the participants can increase. The supported types of urban agriculture in policy should match the needs and goals of the participants and community. An example given by Kirby et al. (2021) is a community where socialization for immigrants and older populations is the policy priority. Communally farmed urban agriculture is more likely in that setting to deliver these outcomes than individual forms of urban agriculture, like allotment gardens (Kirby et al., 2021). Nevertheless, health outcomes of urban

agriculture are currently viewed as incidental advantages and not the main goal of urban agricultural initiatives. Hence, guidance for health policy regarding urban agriculture is currently lacking.

Therefore, this thesis is the first attempt to increase clarity for policy making by making a visual overview of the existing literature transcending typologies of urban agriculture by looking for the underlying mechanisms that lead to the different health benefits. The goal is that the result would be recognizable for participants of different typologies, also if a mechanism is not yet researched for a specific typology.

1.1 Urban agriculture as concept

As mentioned, there are several definitions of urban agriculture used in the literature. On the one hand, urban agriculture is used as a narrow term for an agricultural activity that is carried out on land in the urban area. On the other hand, urban agriculture is defined broadly as any form of agricultural activity in the urban and peri-urban areas (Viljoen & Bohn, 2014). In line with other European research projects about urban agriculture, this thesis recognizes that urban agriculture embraces many forms, which include a broad range of meanings and perspectives about the concept (EPRS, 2017). This leads to the conceptualization of urban agriculture as the "practice of cultivation, processing and distributing food in and around urban areas" (EFUA, 2020). Subsequently, the peri-urban area will be taken into account in this thesis.

Peri-urban agriculture refers to agriculture at the boundaries of the city. It is often described as the transition zone between urban and rural (EFUA, 2020). Peri-urban agriculture and urban agriculture both have a limited amount of land in these transition zones and are not purely rural in that sense. Furthermore, the peri-urban area suffers from urban pressures. However, the peri-urban area can also benefit from the urban area and its markets (Opitz et al. 2016).

Even though both urban agriculture and peri-urban agriculture will be taken into account, it should be noted that both have a different nature. Figure 2 shows the differences between urban and peri-urban agriculture in the Global North (Opitz et al., 2016). On the one hand, urban agriculture is often known for its micro to small-scale agriculture on non-agricultural land within the established urban area. On the other hand, peri-urban agriculture is predominantly known for small-scale to large-scale agriculture on agricultural land on the borders of the city. In contrast to urban agriculture, peri-urban agriculture cultivates land that is often zoned for agriculture purposes (Opitz et al. 2016).

From the description of these similarities and differences between urban agriculture and peri-urban agriculture, the distinction between the two seems clear. Nevertheless, the distinction between the two is often not absolute or rigid in reality. In many cases, the urban and peri-urban zones overlap with each other (Opitz et al. 2016). Therefore, this thesis will consider both urban and peri-urban agriculture, as the boundary between the two are indistinct.

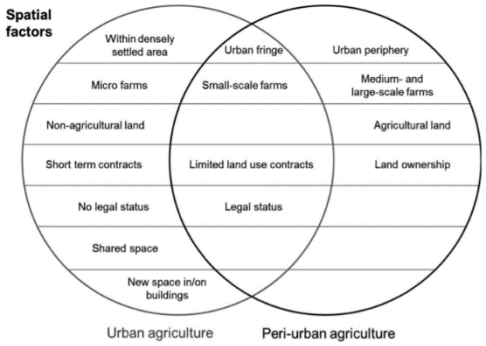

Figure 2 Illustration of differences between urban and peri-urban agriculture (Opitz et al., 2016)

For this study, I chose to use the definitions described in table 1. Previous studies, like research of Gregis et al. (2021), named school gardens, prison gardens and household gardens as community garden. However, for this research I chose to make a distinction between all of these types as the exposure to elements in the urban agriculture initiative might differ for these different contexts.

Table 1 Description of typologies of urban agriculture used[1]

Type of urban agriculture	Description
Unspecified	Urban agriculture or gardening not further described or specified in the article
Urban farm	Urban agriculture initiative with the main purpose to produce food (for profit)
Home garden	Urban agriculture initiative in the own garden at home
Community garden	Urban agricultural initiative, where the overall area is tended collectively by the members
Allotment garden	Urban agricultural initiative, where parcels of land (plots) are tended individually by the holders of this plot (van den Berg et al, 2010).
Therapy garden	Horticultural intervention (healing garden, horticultural
Experience garden	Urban agricultural initiative with the aim to let urban residents the experience with food production
School garden	Urban agricultural initiative located in or around an educational institution, related to this institution.
Rooftop garden	Urban agricultural initiative located on a building
Vertical garden	Urban agriculture initiative that uses vertical production methods

[1] The term community garden in some countries, like the United States, Canada and Australia, is used for both community gardens and allotments (Genter et al. 2015). For this research, I chose to make a distinction between the two by defining allotment gardening as an activity of individual responsibility for a plot, while community gardening does not involve this responsibility for a unique personal plot (Genter et al., 2015).

1.2 Urban agriculture in Europe

Through out Europe, several patterns concerning urban agriculture are visible (Lohrberg et al. 2016). In the zone from the Benelux to Italy, urban agriculture appeared to be subject to a form of controlled urbanization. Therefore, urban agriculture reacts to the changing demands from the city. The main purpose of urban agriculture in this area is not the food supply, but rather other purposes, such as recreational, environmental and social purposes, are favoured.

In the eastern Europe zone, adaptation to changing demands is not happening to the same extent. Likely, this can be attributed to the socialistic economic system, which is holding back entrepreneurial development through restrictions of private investments. Despite the different development stages of urban agriculture in Europe, development is an ongoing process in this area. (Lohrberg et al., 2016).

The different development stages and purposes of urban agriculture in Europe should be considered before generalizing urban agriculture as one concept. Therefore, diversity of urban agricultural initiatives is captured through out this thesis project by the later described typology.

1.3 Urban agriculture in European policy

As noted earlier, there are challenges fitting urban agriculture into agricultural policies like the CAP. However, urban agriculture initiatives are connected to a broader range of EU policy areas than merely agricultural policies. Curry et al. (2014) identified nine other policy areas that were considered relevant to urban food production. Areas recognized were e.g., those related to healthy living and alleviation of social problems. Currently, urban agriculture is not involved in policies related to the health domain. Besides, the existing regulatory framework for plant health, animal health and food quality

issues is needed to be considered in when talking about urban agriculture. That would make the policy landscape for urban agriculture even more complex. Therefore, the paper expresses an urgent "need for renewal" when it comes to European policy, to recognize complexity and cater the complexity of urban agriculture (Curry et al. 2014).

1.4 Health benefits as a concept

Before being able to research the mechanisms underlying the health benefits of urban agriculture, health benefits should be defined. Alike urban agriculture, health is a broad term that is defined in different ways with varying implications.

The World Health Organisation (WHO) describes health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity". The WHO has adopted this definition since 1948 (WHO 2006). The implication of this definition is a dichotomy between completely healthy individuals and everyone else. At the moment of establishment, this inclusion of physical, mental, and social domains was new: it overcame the stage of seeing health as the absence of disease (Huber et al. 2011). However, with the aging population, the illness pressure changes from infectious diseases to chronic diseases, and the criticisms rose. The definition received most criticisms due to the word 'complete' (Huber et al. 2011). With the increasing ability to detect diseases in an early stage and the increase of chronic illnesses, one might argue that nearly anyone is completely healthy. That is why Huber et al. (2011) proposed a new definition of health: "The ability to adapt and self manage in the face of social, physical and emotional challenges." (Huber et al. 2011, p.2). The implication of this definition is that an individual might have a chronic illness, but might not be considered as ill, due to this illness not excluding someone from participation in society. It is focused on resilience to challenges in daily life in the social, physical and emotional domains, rather than a binary examination of whether or not a person suffers from a condition.

1.5 Biopsychosocial approach

To capture all domains of this definition the biopsychosocial approach will be used in this thesis to consider the diversity of possible health benefits. The biopsychosocial approach was first published by Engel (1977) and was developed to bridge the mind-body dichotomy in the dominant biomedical model in health sciences (Frankel, Quill, and McDaniel 2003). The approach starts from the idea that all actions of living systems from cell level to social context should be governed by similar principles (Frankel et al. 2003). Specifically, this means that biological, psychological, and social processes are interacting and determine physical health or illness (Frankel et al. 2003). The emphasis shifts from a biomedical focus towards a more patient-centred method in this approach.

For this thesis, I categorized the concept of health and health outcomes into physical health (e.g. body mass index and blood pressure), mental health (e.g. emotions, mood and stress relief), social health (e.g. social cohesion and community support), nutritional health (e.g. fruit and vegetable consumption and preferences) and subjective health was also included as a measure of overall health that is known to be related to mortality (DeSalvo et al. 2006). As the literature contains of a considerable body devoted to nutritional health (e.g., food security, fruit & vegetable intake, eating behaviour) which is related to interrelated and overlapping health domains, I decided to identify this as a separate category.

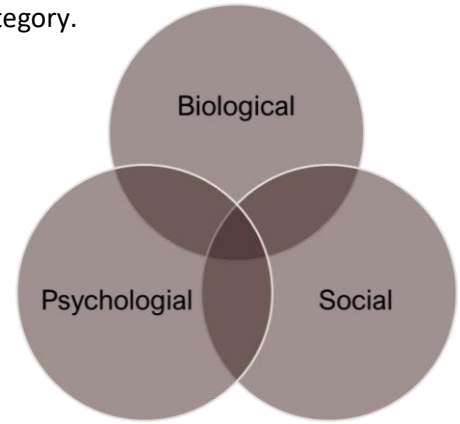

Figure 3 Biopsychosocial model

adjusted from Engel, G. (1977). The need for a new medical model: a challenge for biomedicine. Science, 196(4286), 129–136.

Box 1: European Forum for a Comprehensive Vision on Urban Agriculture

This thesis is performed in the bigger context of the European Forum for a Comprehensive Vision on Urban Agriculture (EFUA). As mentioned, the EFUA aims to unlock the potential of urban agriculture by an increasing knowledge, increasing deployment and improvement of policies in this field (EFUA, 2020).

Several institutions from the Netherlands participate in the EFUA, among which several researchers from Wageningen University. A work package of this project is managed by the chair groups Rural Sociology, Health and Society and Wageningen Plant Research. This work package is aimed at updating knowledge on the types and benefits of urban agriculture, to become a starting point for understanding the benefits of urban agriculture. This understanding will support a European agenda on urban agriculture, co-designed within EFUA. This provided the starting point for my thesis

Chapter 2: Research context

2. Research context

2.1 Problem definition

2.1.1 Problem statement and knowledge gap

The main challenge tackled in this thesis is the absence of an overview and clarity provided in the literature about mechanisms underlying the health benefits of urban agriculture.

An increasing body of scientific evidence regarding health benefits of a specific type of urban agriculture exists. However, no overview of the range of health benefits yielded in the different types of urban agriculture is available. Furthermore, the reported outcome measures differentiate substantially, as well as the reported contexts influencing the outcomes. Moreover, similarities and differences in health benefits resulting from urban agriculture types are not yet mapped. The lack of an overview and clarity complicates the decision-making process in regard of the characteristics that should be present new initiatives to comply with local or national policy aims. The literature thus describes a health benefit that can be derived from multiple types of urban agriculture in several differentiating contexts, but there is not an overview of general mechanisms that could guide future development of urban agriculture.

Figure 4 Graphical representation knowledge gap

2.1.2 Research objective

The research objective of this thesis is to investigate which mechanisms are underlying the health benefits of urban agriculture and how these are interrelated with each other. Moreover, this thesis aims to develop a framework that provides a visual overview of the mechanisms and outcomes of this research.

The framework should function as a tool to increase integration of urban agriculture in European policy and practice. Therefore, this framework should be accessible for a broad range of stakeholders. To facilitate accessibility, the design of the framework should be understandable for a lay audience without explanation.

2.1.3 Research question

To reach the research objectives, the main research question that should be answered is: "Which mechanisms are underlying to the health benefits of urban agriculture?". Consequently, a sub-question to be answered is: "What are the health benefits of urban agriculture?" with the following sub-question being: "What are possible mechanisms that lead to the health benefits of urban agriculture?". Building upon these sub-questions, a framework will be developed that graphically shows the mechanisms underlying the health benefits of urban agriculture and their interrelations. Next, the last sub-question that should be answered is: "What is a possible graphical representation of the mechanisms underlying the health benefits of urban agriculture?".

2.1.4 Relevance of the study

Academic

Currently, the literature about the impact of urban agriculture on health outcomes is diverse. The diversity of evidence in the literature could be explained by different methodological approaches, focus on one specific aspect of urban agriculture or the socioeconomic context where urban agriculture is implemented. Limited number of systematic reviews are available on this topic, all the available reviews focus on one specific aspect of urban agriculture (e.g., community gardens or allotment gardens) or specific outcome (e.g., vegetable consumption or physical activity). This research provides a broader overview of the literature. By synthesizing the literature insights is provided into understanding the general and common

health benefits of urban agriculture different kinds of urban agriculture for individuals and communities involved. Additionally, this research focuses on Europe, where the majority of the reviews focuses on non-European countries or other continents. By making an outline of the available literature, knowledge gaps appear and future research can be targeted to fill in the knowledge gaps.

Socio-political

The aim of this study is to make an overview of the existing evidence about mechanisms underlying to the benefits of urban agriculture and translate this into a framework. This is useful for policy purposes as the scattered knowledge on urban agriculture benefits makes it difficult to help stakeholders in urban planning and could possibly misguide decision making (Audate et al. 2019). Identifying the underlying mechanisms of the relationship between urban agriculture and its outcomes, is an important mean of informing changes in policy and practices. Especially if urban agriculture is to be supported as a food system solution (Mead et al. 2021). Therefore, this field would benefit from synthesis of scientific knowledge on this matter.

2.2 Research design

2.2.1 Research process

This research consists of four steps following up on each other. First, a systematic literature review was conducted, which led to a conceptual framework visualizing the mechanisms underlying the health benefits of urban agriculture. Second, interviews were conducted to test the comprehensibility and suitability of the framework amongst urban agriculture participants. Based on this feedback the design was revised. The research process and order of different methodologies used are graphically put in the flowchart of figure 5.

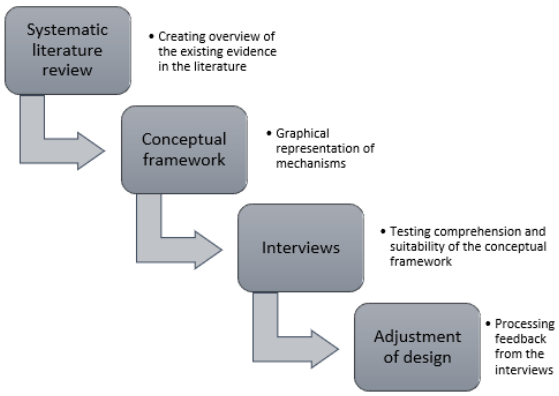

Figure 5 Visual representation of research process

2.2.2 Methodology

To investigate the mechanisms underlying the health benefits of urban agriculture, a systematic literature review was conducted according to the PRISMA guidelines for systematic literature reviews (Page et al. 2021). The search strategy included both a set of urban agriculture-oriented keywords and health-orientated keywords (see table 2). Scopus, PubMed and Web of Science were used as databases with the following search question: TITLE-ABS-KEY (("urban agriculture" OR "urban farm*" OR "allotment garden" OR "community garden" OR "vertical farm*" OR "vertical garden*" OR "vertical agriculture" OR "rooftop") AND ("health benefits" OR "health promotion" OR "health status" OR "wellbeing" OR "physical health" OR "psycholog*" OR "therapy" OR "healing")).

In addition to the articles derived from the search term, the reference lists from the first thirty articles were scanned on relevant articles. After the first thirty articles, saturation occurred as the same relevant articles were listed in the references. Stress as a search term was left out of the search question, as this resulted in an increase of additional irrelevant articles due to the fact that stress is a term used in plant research concerning plant growth.

Peer-reviewed articles published in the English language were included and were transferred to reference manager software (Mendeley and Rayyan) where all duplicates were removed. Moreover, the peer-reviewed articles were

*Table 2 Search question terms | *indicates multiple ending options*

Urban agriculture search term	Health search term
Urban agricultur*	Health benefits
Urban farm*	Health promotion
Allotment garden*	Health status
Community garden*	Wellbeing
Vertical farm*	Physical health
Vertical garden*	Psycholog*
Vertical agriculture	Therapy
Rooftop	Healing

considered if they describe an original qualitative, quantitative, or mixed-method research. Literature reviews were included, to provide an overview of general trends regarding the mechanisms. Additionally, dissertations, letters and conference abstracts will be excluded, but reference lists were checked for relevant publications. Articles were not excluded based on publication date restrictions. The articles were considered if urban agriculture was defined as a food growing initiative in an urban setting and the study was conducted consequentially in an urban area. Urban agriculture should be the main interest of the article. Furthermore, a study was included if it reported positive or negative health outcomes of urban agriculture in the physical, mental, or social health field. Articles reporting ego states were not included, as no link with health was reported.

Articles from the Global South were excluded after (due to time restrictions) and expected differing context from Europe. Articles were also excluded if the country was partially located on the Global South. Before the decision to exclude the Global South from the literature review was made, outcome differences were checked between the global North and South by means of a sample. Research focussing on Latin-America and Africa were different than the research focused on Europe, as the context is substantially different. Research conducted in Oceania was not substantially different than the research focused on Europe, with exception of research focused on Māori tribes. Furthermore, the reported outcomes from articles focusing on Oceania were comparable. However, there were three articles from Australia reporting on health outcomes that were not present in the outcomes of the search string on the global North. Of these three articles, the research context was carefully read and decided to be comparable to Europe. Therefore, it was decided to include these three articles with a research focus on Australia.

The search string identified 729 articles in total on Scopus (N=342), PubMed (N=240) and Web of Science (N=147). Additionally, the reference lists of the articles from this list were searched for additional relevant articles until saturation. This led to an additional 130 articles. Among the total 859 articles duplicates were excluded, which resulted in 595 unique entries. The articles were screened by application of the eligibility criteria. Of the 595 unique entries, 421 articles were excluded in the first selection round based on the abstract and title. Based on the full-text assessment, 88 of the 174 remaining articles were excluded in the second selection round., resulting in a total of 86 included studies in the systematic literature review. The systematic reviews were used to identify reoccurring themes, hereafter the remaining articles were used to add and modify the identified mechanisms.

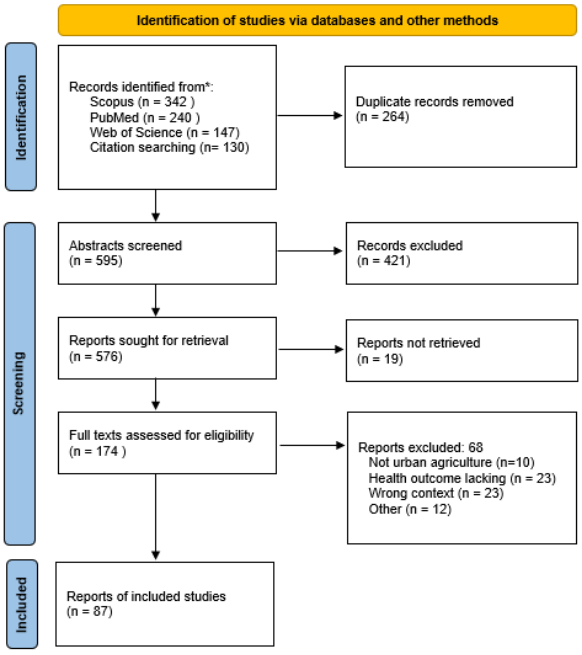

Figure 6 Prisma flow diagram systematic literature review

2.2.3 Data collection & Data analysis

Once the articles were selected, data from the articles was organized in a table. The following data was recorded: author, year, country of interest, sample size (N), mentioned characteristics of participants, type of urban agriculture (see table 1), study design, study approach (qualitative, quantitative or mixed method) and health outcomes reported (see table 3; outcomes for individual or community).

Table 3 Health outcomes coding examples

Category	Example words under coding
Mental health	Psychological wellbeing
	Stress relief
	Emotional wellbeing
Physical health	BMI
	Physical activity
Social health	Social connectedness
	Community support
Self rated health	Self rated health
	Subjective wellbeing
Nutritional health	Vegetable consumption
	Fruit and vegetable preference
Health risk	Soil pollution
	Social exclusion

The literature was transformed into a conceptual framework that shows the mechanisms in urban agriculture that lead to certain health benefits. The outcomes were synthesizing thematically to come to identification of underlying mechanisms. An inductive approach was used to identify reoccurring themes in the articles. To do so, the identified systematic reviews about specific types of urban agriculture were first analysed. From this starting point, the reoccurring themes were related to each other with the help of the other articles.

After the development of the framework, the comprehensibility of the framework was tested and feedback from participants was gathered via semi-structured interviews. Nine interviewees involved in urban agriculture representing different typologies of urban agriculture were interviewed. These interviewees were recruited through snowball sampling, starting from a social media post in my personal network. On social media I asked to name urban agriculture initiatives they could think of. These cues were followed up by contacting the initiatives via mail or social media. It appeared challenging to get in contact with rooftop and vertical farming initiatives, as they were asked repeatedly by other researchers and the number initiatives is limited in the Netherlands.

Therefore, I asked my network again to name urban agriculture initiatives, but this time specifically for rooftop and vertical farming initiatives in the Netherlands or abroad. Nevertheless, initiatives did not respond or continue to respond after follow-up of these new cues. It was decided after these steps to proceed without these typologies represented due to time limitations.

The characteristics of the interviewees are shown in appendix I. One of the interviews was conducted in English, as the interviewee felt more comfortable with this language. The other interviews were conducted in Dutch. The typology was filled in for the urban agriculture initiatives to which the stakeholder was related based on the interviews. The result of that can be found in appendix II.

Figure 7 Case study locations

Most of the typologies found in the literature were represented in the interviews. The geographical distribution of the case studies over the Netherlands is shown in figure 7.

On-site observations were conducted to validate the findings of the systematic literature review and the developed framework. On all locations, a tour was given by the interviewee in the urban agriculture initiative they were related to. Next, the informed consent forms were given to the interviewees and signed. During the interview, the first version of the framework was shown in colour to the interviewees. All the interviews were conducted according to the interview guide, which can be found in the appendix (IV). The interviewees were first asked about their own experiences, so the answers could not be influenced by the framework. After, the framework was shown to explore the recognizability of the mechanisms described the value of the framework for them and the clarity of the framework. The interviews lasted 46 to 79 minutes. The feedback from the interviews was used to redesign the framework.

The interviews were transcribed and afterwards coded in Atlas.ti via deductive and inductive coding. For the health benefits described by participants before showing the framework, inductive coding was used with the coding categories being the framework categories to allow for comparison. Deductive coding was used for the feedback on and testing of the comprehensibility of the framework.

Chapter 3: Results

3. Results

In this chapter, I describe the results from the systematic literature review. First the characteristics of the data from the systematic literature review are discussed. Second, mechanisms underlying the health benefits of urban agriculture derived from the literature. Third and lastly the benefits from urban green are discussed as this can not be seen separate from urban agriculture.

3.1 Systematic literature review

The aim of this paragraph is to provide an overview with the characteristics of the data derived from the systematic literature review.

As visible in figure 8, there is a growing interest in this topic, that is supported by a rising number of published articles since the year 2000 on Scopus, PubMed and Web of Science.

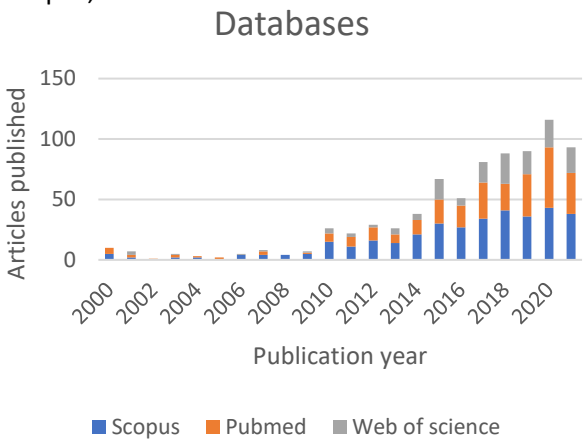

Figure 8 Scopus, PubMed and Web of Science publication trends between 2000 and May 2021

Of the 86 included articles, the research area was located in the United States in 34% of the articles. Followed by Japan (9%) and the United Kingdom (9%) as host for the researched areas. In 22% of the included articles, the research area was located in more than two countries. This is also visible in figure 9. The sample size in the studies had a broad range running from N=5 to N=2269.

With 73% of the articles focussing on health benefits for the individual participating in urban agriculture themselves, the minority of the articles reflect the health benefits for the community as a whole. The majority of the articles has adults as target group (see figure 10). One quarter of the articles focused on specific groups such as immigrants and refugees (N=5),

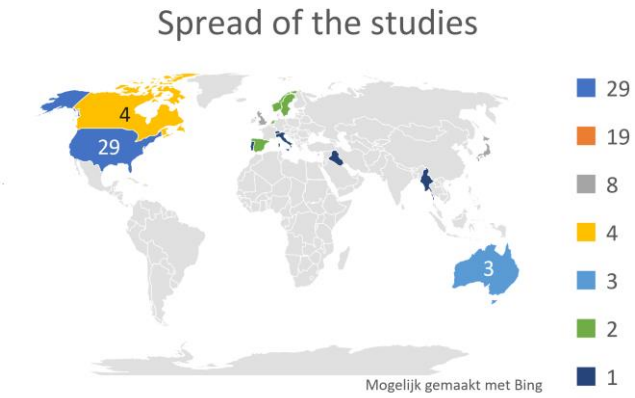

Figure 9 Distribution of geographical interest

vulnerable and disadvantaged communities (N=5) and indigenous community members (N=3). When stratifying the articles for the studied type of urban agriculture, results are shown in figure 11. The main type of studied urban agriculture initiative were community gardens with 38%. Next, 14% of the articles studied allotment gardening as form of urban agriculture. It is important to note that also 14% of the articles did not specify which type of urban agriculture was studied.

The research approaches where almost equally divided amongst the qualitative approach (40%) and the quantitative approach (36%); the remainder of the articles has a mixed method approach. A cross-sectional survey was the most used research method (N=23; 26%).

The reported health outcomes were coded as mentioned in the methodology, which resulted in the majority of the articles reporting mental health outcomes and the minority of the articles reported general wellbeing and self reported

health outcomes. Even though health risks were not the focus of the search string, nine articles reported possible health risks of urban agriculture.

Most articles reported multiple health outcome categories. The mental health benefits of urban agriculture where the most reported health comes (N=65) across the research approaches: qualitative (N=27), quantitative (N=24) and mixed methods (N=15). Only for general wellbeing & SRH (quantitative) and nutritional health (qualitative), there was a dominant research approach. For the other health outcomes, the distribution was somewhat similar

Implications

The findings from this first analysis have several implications for my thesis and future research. First of all, there is a lack of evidence regarding the health benefits of rooftop and vertical farming, which implicates that assumptions should be made about the related mechanisms for these typologies. Second, a fast amount of the articles is cross-sectional. Therefore, causality can not be described for the relations found.

In the findings from the systematic literature review I identified underlying mechanisms leading to mental, social and physical health benefits.

I grouped these mechanisms into four separate categories, around which I designed a framework that is shown in figure 12. The following paragraphs elaborate upon these mechanisms and the underlying sub-mechanism.

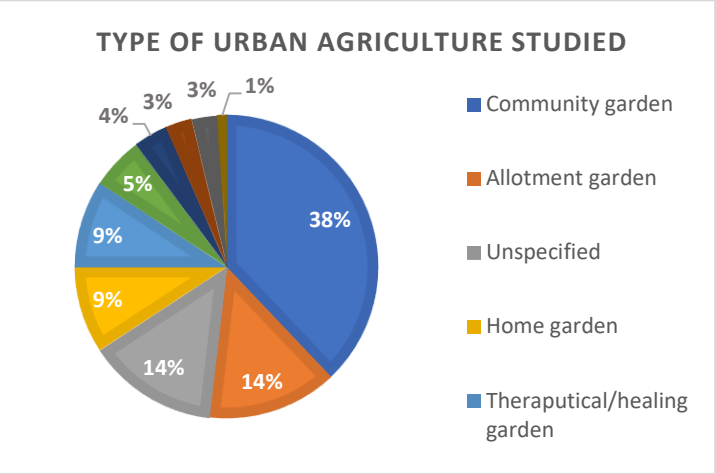

Figure 10 Distribution of the typologies studied

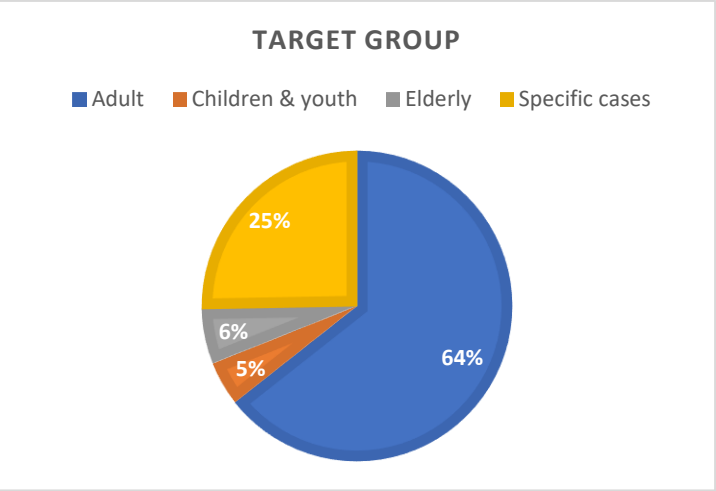

Figure 11 Distribution of the target groups of interest

Table 4 Over of health outcomes reported and research approaches

Health outcome	N	%	Qualitative	Quantitative	Mixed methods
General wellbeing & Self reported health	27	11%	8	16	3
Physical health	48	20%	21	17	10
Mental health	65	28%	27	24	15
Social health	47	20%	18	17	12
Nutritional health	42	17%	20	10	12
Health risks	9	4%	7	0	2
N; %			34; 40%	31; 36%	20; 24%

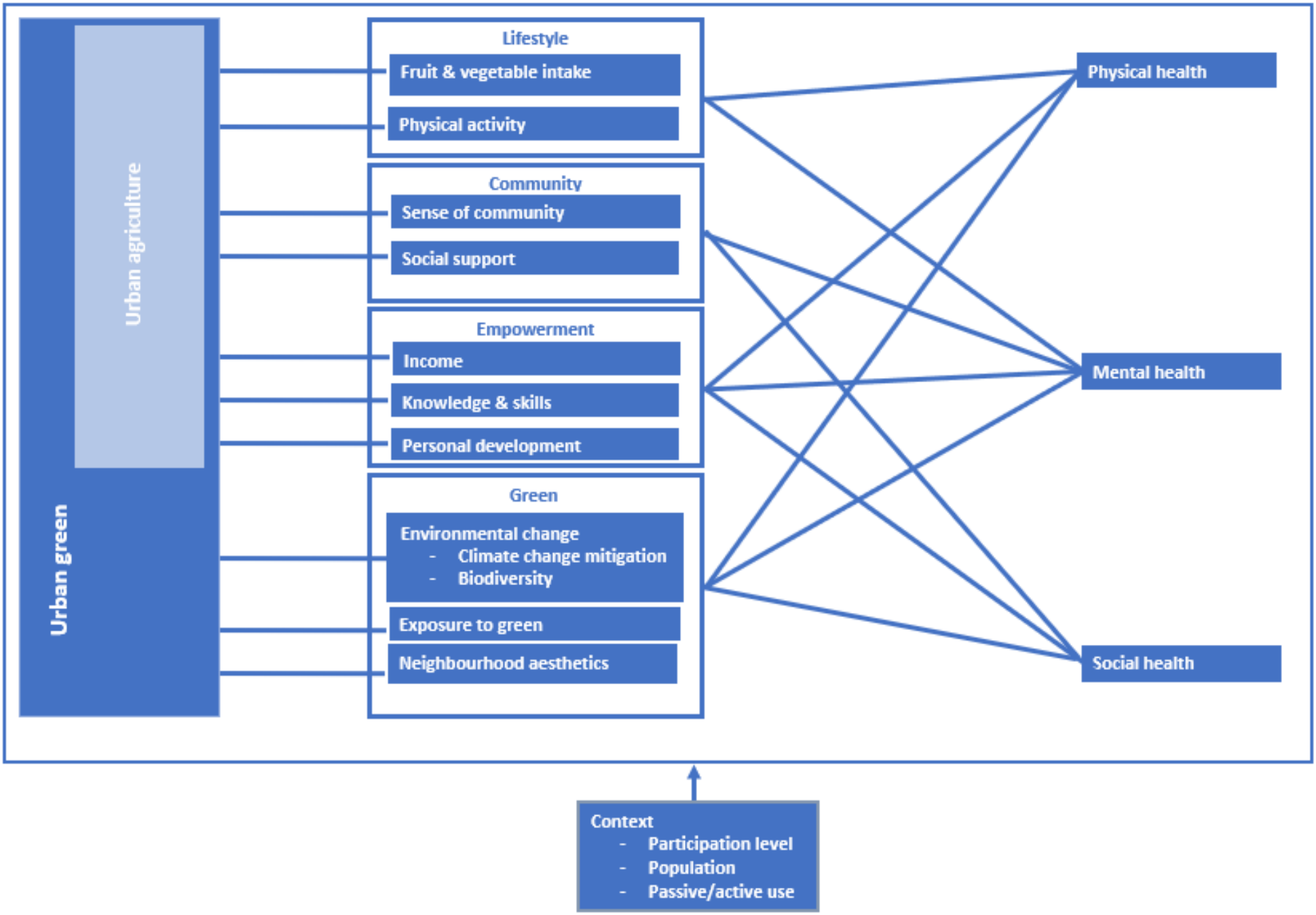

Figure 11 Developed framework visualizing the mechanisms underlying the health benefits of urban agriculture

3.2 The mechanisms underlying health benefits from urban green

In this paragraph, I discuss the mechanisms underlying the health benefits of urban green in general. This is the first step towards developing an overview of the mechanisms underlying urban agriculture as health benefits of urban agriculture are related to the health benefits of urban green. The health benefits of urban green and urban agriculture partially overlap. Urban agriculture is a part of urban green, but urban green also includes other forms of green such as parks and private gardens that are not related to food production. Therefore, the general mechanisms underlying the health benefits of urban green that apply to urban agriculture, based on the literature review, are discussed first. Nevertheless, the mechanisms underlying the health benefits of urban agriculture specifically are the scope of this research. For an in depth overview of the health benefits of urban green and the corresponding underlying mechanisms, I would like to refer to the literature (e.g. Hartig et al., 2014).

Three main underlying mechanisms were identified in the literature that link urban green to human health outcomes: the biophilia hypothesis, the biodiversity hypothesis and the ability of urban green to mitigate the effects of climate change. These three mechanisms underlying the health benefits of urban green are explained in the following paragraph.

The biophilia hypothesis is based on the idea that humans are intrinsically attracted to other species and nature, as the evolution of our species was driven by the interaction with the natural environment (Wilson et al., 1984 cited in Aerts et al., 2018). Under this hypothesis, it is expected that people prefer and select biologically diverse environment and derive mental benefits from exposure to green (Frumkin 2001; Grinde and Patil 2009). Theories related to this hypothesis are the Stress Recovery Theory of Ulrich (Ulrich et al. 1991) and the Attention Restoration Theory of Kaplan & Kaplan (Kaplan and Kaplan 1989) that suggest that exposure to green facilitate recovery from physiological stress, mental fatigue and assist the restoration of directed attention.

However, mental health is not the only health outcome affected by exposure to green. Particularly during the prenatal development and early live exposure to green is important (Aerts et al., 2014). The amount of green in the neighbourhood where the mother is living, positively affects the birth weight of their infants. Additionally, residential greenness has been associated with reduced obesity prevalence and has a positive effect on blood pressure in adolescents. Long term exposure to green has been associated to reduced all-cause, respiratory, cardiovascular and cancer mortality and to mental health. The positive effects of exposure to green space have been demonstrated over distances varying between 150m and 5 km (Aerts et al., 2014). Next to that, urban green also contributes to experienced social cohesion (De Vries et al. 2013) and green space can reduce the feeling of loneliness by increasing the feeling of experienced social support (Maas et al. 2009).

Even though exposure to urban green benefits health, it should be noted that some of these benefits could be accelerated through urban agriculture. Participation in urban agriculture can be seen as an active engagement in urban green, which is different from passive urban green use like reading in the park or meeting with friends outside. Holt et al. (2019) revealed active engagement in urban green results in a higher rated quality of life, a better overall mood and lower perceived stress levels.

The biodiversity hypothesis states that exposure to biodiversity improves the immune system by regulating the species composition of the human microbiome. Under this hypothesis, exposure to beneficial environmental microbiota reduces the prevalence of allergies, asthma and other chronic inflammatory diseases. Exposure to natural environments during early life also has a number of important long-term effects. The exposure to beneficial microbiota in the environment during early life has profound positive effect on the development of the

immune system and on the prevalence of chronic inflammatory diseases.

The biodiversity in urban areas is often lower than in natural environments and the prevalence of asthma and atopy seems to be significantly lower in children living on family farms compared to children living in an urban area (Ege et al. 2011). This outcome is supported by research of Hanski et al. (2012) that showed that atopy decreases with increasing environmental biodiversity. Microbiotas are very likely to mediate the effects of biodiversity on human health (Aerts et al., 2018). Additionally, stress restoration is also positively related to the number of plant species (Young et al., 2020). Which suggests that the biodiversity hypothesis is related to physical and mental health.

Regulation of climate can be assisted by urban green. Next to air purification, maintenance of soil fertility and pollination, urban green is known to regulate the local climate and global climate (Camps-Calvet et al. 2016). Through planted trees, microclimates are improved by reducing the urban heat island effect in hot seasons and lowering the wind-chill factor in cold seasons (Millican, Perkins, and Adam-Bradford 2019). The urban heat island effect consists of higher temperatures during the day, with reduced cooling during the night and increase air pollution. The urban heat island effect contributes to heat-related mortality and morbidity like respiratory difficulties, heat cramps and non-fatal heat strokes. Urban green can decrease the surface temperature by ten degrees Celsius, compared to an area without vegetation (Tsilini et al. 2015). The biodiversity in urban green supports ecosystem services that mitigate heat (Aerts et al. 2018).

In conclusion, the benefits of urban green related to urban agriculture, can be summarized in the benefits of exposure to green in general (biophilia hypothesis), the benefits of biodiversity (biodiversity hypothesis) and the benefits of the capacity of urban green to mitigate the effects of climate change. The exposure to green affects social, physical and mental health, while biodiversity and climate mitigation have an impact on the primarily physical health.

3.3 The mechanisms underlying health benefits from urban agriculture

In the following paragraph the mechanisms underlying to the health benefits of urban agriculture are discussed. The chapter is based on the literature review and structure according to the inductive categorization described in the methods section. First, I describe all identified mechanisms underlying health benefits of urban agriculture found in the literature with the related health outcomes. If applicable, sub-mechanisms are described and the implications for the framework are drawn up. Second, context specific influences on the framework are described, as mechanisms vary in deviant situation. After that, a conclusion is drawn up to come to an answer to the first two sub-questions: "What are the health benefits of urban agriculture?" and "What are possible mechanisms that lead to the health benefits of urban agriculture?".

Lifestyle

One of the categories leading to health benefits I derived from the literature is 'lifestyle' with **fruit and vegetable (F&V) consumption** and **physical activity** as underlying mechanisms to the health benefits of urban agriculture.

Fruit and vegetable consumption

In 18% of the articles reporting nutritional outcomes of urban agriculture included in the study, the majority of the articles focus on F&V consumption of urban agriculture participants. Several articles show an increased F&V consumption among participants in urban agriculture and their household members, than others who do not participate (Alaimo et al. 2008; Audate et al. 2019; M T Garcia et al. 2018; Litt et al. 2011). For example, Audate et al. (2019) showed in their literature review that participation in urban agriculture was reported to have an impact on nutritional status, by increasing the F&V intake and food diversity. Moreover, Garcia et al. (2018) reported in their literature review that urban gardening increases F&V consumption, gives better aces to healthy foods, increases the value of cooking, adequate food and healthy food and enhances the importance of organic production.

There are several sub-mechanisms hypothesized in the literature to explain the relation between participation in urban agriculture and increased F&V intake that I will describe in the upcoming paragraphs.

Improved **accessibility** to F&V is an often-cited benefit of urban agriculture (Garcia et al., 2018), as urban agriculture simply may provide greater access to fruit and vegetables by nature. The majority (75%) of the articles investigating the effect of urban agriculture on food security reports a positive impact (Audate et al., 2019). Additionally, improved perceived accessibility to F&V might decrease stress levels that are identified as a driver for poor health and unhealthy dietary choices (Mead et al. 2021).

The systematic literature review of Machida and Kushida (2020) showed an impact of urban agriculture on **dietary awareness** among children, adults and elderly specifically among Japanese. Particularly agricultural experiences here impacted the gratitude for food. **Dietary knowledge** also increased among children but was not investigated among adults. However, western studies showed increasing dietary knowledge among adults. In this study, it was suggested that dietary knowledge and awareness were the drivers for the reported changes in dietary behaviours (Machida & Kushida, 2020).

In the literature**, healthy eating motivations** and **ethical or sustainable eating motivations** are often cited as reason to engage in urban agriculture (Ruggeri, Mazzocchi, and Corsi 2016). Literature shows that people with these type of motivations in daily life report healthier diet patterns. This might as well explain the relation between urban agriculture and increased F&V consumption. Additionally, people who report ethics and environmental concern in relation to food, have healthier diets and eating attitudes (Mead et al. 2021).

As mentioned before **exposure to nature** has benefits on wellbeing and stress reduction, which impacts dietary choices in return (Mead et al. 2021). As urban agriculture serves as a way to reconnect people with nature, this aspect might have an impact on consumption patterns (Mead et al. 2021) Exposure to nature increases healthier dietary choices, as it encourages people to think about the consequences of their decisions in the future. Therefore, the exposure to nature might be a mediator for the relation between urban agriculture and F&V consumption (Mead et al. 2021).

The **consistent exposure to F&V** is another hypothesized mechanism to explain the increasing F&V intake. Particularly for youth, nutrition is improved by encouraging participants to try fruits and vegetables in urban agriculture they have not tried before. Consistent exposure can overcome an aversion for certain foods (Mead et al. 2021).

Another mechanism increasing F&V consumption described in the literature is through **emotional connection** with F&V. Participants in urban agriculture report to be more willing to eat the F&V that grew and was picked by themselves (Hale et al. 2011). Participants enjoy the taste of the food and participation "awakes the senses and stimulates a range of responses" that influences feeling of connection with the garden. This feeling of emotional connection with the garden, influences willingness to eat the food from the garden. Through this emotional connection, the consumption of F&V increases (Hale et al., 2011).

However, few of the hypothesis are empirically investigated. Mead et al. (2021) investigated the potential mediating factors in the relation between participation in urban agriculture or proximity to urban agriculture and an improved diet. In order to find the mediating factors leading to an improved diet from urban agriculture, five of the above-mentioned hypotheses were tested (perceived accessibility of fruit and vegetables, health related food choice motivation, ethics related food choice motivation, connections with nature, psychological distress). Their analysis shows that the relation between urban agriculture and improved diets can be indirectly explained by health and ethical related food choices motivations. Counterintuitively, it also showed that urban agriculture can be associated with a poorer diet quality via higher levels of psychological distress. However, this relation can also be explained by people participating in urban agriculture as a way of coping with stress. Urban agriculture was also related to better perceived access to F&V and nature connectedness, but this did not mediate the relation with a better diet. The fact that F&V consumption is only part of the overall diet, might be a possible explanation for the lacking mediation (Mead et al. 2021).

The increase of F&V consumption due to participation in urban agriculture should be included in the framework as underlying mechanism, as greater F&V consumption is associated with prevention of chronic diseases (Boeing et al. 2012). Also, there were no contradicting outcomes regarding F&V consumption across the different urban agriculture types. Nevertheless, it should be mentioned that not all typologies were represented in the research regarding F&V consumption related to urban agriculture. Therefore, further research looking into the relation between rooftop and vertical farm participation, and F&V consumption is desired. The lack of empirical research after the underlying sub-mechanisms leading to increased F&V consumptions implicates that these should not be included in the framework until they are empirically validated.

Physical activity

Next to F&V intake, I identified increased physical activity as a mechanism underlying the health benefits of urban agriculture. It is self-evident that physical activity might be stimulated in other places as well. However, physical activity in natural environments is associated with a lower risk of poor mental

health, than physical activity in other environments (Mitchell 2013). Therefore, the outdoor physical activity in urban agriculture can add value for mental health over physical activity indoors.

Physical activity goes hand in hand with participation in urban agriculture and gardening specifically (Alaimo, Beavers, et al. 2016). Physical activity can be stimulated to the level of weekly physical activity recommendations through urban agriculture, especially during spring and summer months (Park, Shoemaker, and Haub 2008). Additionally, allotment gardeners report to be more physically active and more engaged in physical activities than non-gardeners of their age (Van Den Berg et al. 2010). Urban agriculture can increase physical activity levels, as it provides a safe space to be physically active (Alaimo, Beavers, et al. 2016; Alaimo, Crawford, and Snyder 2016)

However, it should be taken into account that the physical demands of participation in urban agriculture might influence the findings about physical activity, as participation is only accessible for physically active people (Genter et al. 2015). This potential influence is referred to and acknowledge by the 'healthy gardener effect' (Van den Berg et al., 2010). As there is a social pressure to have a good looking plot, people with decreased ability to be physically active are discouraged to continue gardening or are advised to give up their plot (Van den Berg et al., 2010). Nevertheless, Park et al. (2008) noted that gardening activities can be tailored for elderly to maximize the health benefits they derive from urban agriculture. Moderate-intensity activities engaging the lower and upper body are favoured for this age group, like digging, fertilizing, raking and digging (Park et al., 2008). In this way, people less able to be physically active, can still participate in urban agriculture and derive health benefits from this participation.

Therefore, physical activity should be in the framework as underlying mechanism leading to health outcomes as increasing physical activity resulting from urban agriculture can prevent obesity and other chronic diseases. Zick et al. (2013) showed that participants of community gardening had a significant lower body mass index (BMI) in comparison to their neighbours not participating in urban agriculture. Additionally, older allotment gardeners who were more physically active than non-allotment gardening neighbours, report significantly higher health scores than the non-allotment gardening neighbours (van den Berg et al., 2010). Again, not all urban agriculture typologies were represented under these mechanisms. So, the generalisability of this mechanism should be tested for the other typologies.

Empowerment

The second category I derived from the literature focuses on the opportunities provided by urban agriculture for the individual and is covered by the term 'empowerment'. The mechanisms underlying the health benefits of urban agriculture described under this category are **generating income**, **knowledge & skills** and **personal development**.

Generating income

Certainly, economic factors are more valued by working farms as form of urban agriculture, compared to allotment gardens or community gardens. Additionally, economics benefits for participants increase when produce is sold, instead of shared and if participants are paid for their labour (Kirby et al. 2021). Nevertheless, economic motivations are the least important driver for participation regardless of the urban agriculture type (Kirby et al. 2021). Although socio-demographic trends influence these priorities, meaning that economic importance of participation in urban agriculture might differ in context other than relatively wealthy cities in Europe (Kirby et al. 2021)

The majority of conducted research to the economic aspects of urban agriculture is not focused on the European or western context, but on the African context (Audate et al. 2019). However, some research is conducted in North America, concerning the impact of urban agriculture participation on income. Here, it showed that community gardeners saved up to $84 per month by growing own vegetables, while this was $92 per month for the home gardeners (Algert et al. 2016). By saving costs and establishing more income security, experienced stress might be reduced, and wellbeing might be positively impacted. However, no research was found into this topic concerning Europe or the Global North in general.

Knowledge & Skills

Participation in urban agriculture has an educational value (Burke 2018) and stimulates learning in several ways. Under 'fruit and vegetable consumption' the increasing dietary knowledge as a result of urban agriculture participation was already discussed. Therefore, I will not discuss this aspect of education further in this part.

Participating in an community garden stimulates **learning about biophysical and social processes** in the garden, but also contributes to a holistic understanding of the biophysical and social process that affects the health of the own body (Hale et al. 2011). The garden is an effective setting for this, as the contrast of the garden environment with the normal living environment stimulates hands-on learning. The garden environment impacts ecological learning about biophysical and social processes directly, as engagement with these processes is necessary to maintain the garden plot (Hale et al. 2011). The connection and responsibility for living beings such as plants, brings participants back to the present and offers a space to learn about gardening and themselves (Suto et al. 2021). In fact, the process of learning and gaining knowledge in urban agriculture seems to be inseparable from the connection with living beings (Suto et al. 2021)

Additionally, indirect ecological learning also takes place by watching other farmers, asking each other questions and sharing the results of experiments on the farm (Hale et al. 2011). This indirect ecological learning via relationships might lead to more effective and long-term behaviour change. Thus, education as underlying mechanism has no direct impact on physical health, such as increased physical activity or F&V consumption, but has a relational association that contributes to overall well-being (Hale et al. 2011). It was mentioned by Hale et al. (2011) that gardeners first talk about soil, plants or how being in nature makes them feel, before they relate this to other values like healthy food, learning, reciprocity and sharing.

Furthermore, the urban agricultural garden showed to provide a good space to educate Hispanic farmworkers about the effect of pesticides and how to control insects (Carney et al. 2012). Study session in the garden were organized and information was successfully passed through to family members (Carney et al. 2012). The role of urban agriculture participants

as knowledge multipliers within families and communities was also recognized by Garcia et al. (2018). Moreover, Camps-Calvet et al. (2016) reported that learning and education were acknowledge to be the most widely perceived benefit of urban agriculture. The gained knowledge is not only applied to the garden, but also extended to life outside the garden (Suto et al. 2021)

There are no differences in reported outcomes across the typologies, but again not all typologies are represented in the articles reporting on education. To measure expanded social outcomes such as educational value of urban agriculture, methods and metrics should be developed further (Burke 2018).

Personal development

Drivers for beneficial health outcomes of urban agriculture related to changes of individual skills, coping, behaviours or characteristics were identified in the literature. The mechanism 'personal development' covers these individual drivers underlying health benefits of urban agriculture. Personal development is a mechanism that I put under empowerment, as the personal development through urban agriculture might not merely empower participants in the initiative, but in challenges in daily life as well.

The literature reports and increased sense of autonomy, enhanced feelings of competency, improved stress coping skills, increased self-esteem and improved confidence among the dominating mechanisms benefiting health outcomes from urban agriculture (Alaimo, Beavers, et al. 2016; Genter et al. 2015; Quested et al. 2018; Spano et al. 2020; Wood et al. 2016). More over, in the meta-analysis of Spano et al. (2020) an significant positive effect of urban gardening on cognitive functioning was shown.

The effect of urban agriculture on stress is often described in the literature. In my thesis I decided to split stress related outcomes and mechanisms under multiple categories. Coping with stress is a sub-mechanism for which I chose to put it under personal development. However, stress reduction is seen as a mental health outcome in my thesis, that could be stimulated through multiple mechanisms such as increased food security, exposure to urban green or improved coping skills. Participation in urban agriculture is often driven by intrinsic motivation. The ability to act upon intrinsic motivation results in a **sense of autonomy** and enhances **feelings of competency**. These two sub-mechanisms have the potential to improve **stress coping skills** (Quested et al. 2018).

The improvement of stress coping skills among children is also facilitated by urban agriculture, specifically in school gardens (Ohly et al. 2016). In the school garden, children experience positive and negative emotions. In this environment, it was reported that the participants experience improved ability to express themselves and more effective management of the experienced positive and negative emotions (Ohly et al. 2016)

In their case-control study, Wood et al. (2016) showed that **self-esteem** increases during a gardening session. They concluded that frequent short garden sessions (<30 minutes) yield the greatest benefits for health and wellbeing. Furthermore, they suggest that the increase self-esteem does not deteriorate over time. When focussing on children, it is shown that children gain self-esteem through school gardening (Ohly et al. 2016). Low self-esteem is related to mental issues such as anxiety and depression (Wood et al. 2016). Therefore, increased self-esteem is an included sub-mechanism underlying health benefits of urban agriculture.

Besides self-esteem, **confidence** also increased amongst children through participation in a school garden (Ohly et al. 2016) The development of the gardens and their role in maintenance of the gardens provides an opportunity to demonstrate ownership and responsibility, which is beneficial for experienced confidence. Moreover, the garden is particularly beneficial to children who are challenged by the usual academic setting, such as children with learning or behavioural

difficulties (Ohly et al. 2016). Participating in urban agriculture allows them 'to shine in different ways and to experience success' (Ohly et al. 2016).

Nevertheless, it should also be acknowledged that participation in urban agriculture by itself is not skill free and needs time investment (Alaimo, Beavers, et al. 2016). This might induce a selection bias regarding the participants in urban agriculture initiatives and thereby the benefits resulting from participation.

In contrast with the previous mechanisms described, the diversity of typologies reporting on personal development mechanisms is higher. Sense of autonomy, feelings of competency and self-esteem were supported amongst adults and children in different typos of urban agriculture. Nevertheless, increase in confidence was only reported in this systematic literature review amongst children. However, amongst studies focusing on personal development of adults in urban agriculture no contradicting or neutral results were reported. Therefore, I decided that all of the sub mechanisms reported by the literature should be included in the framework.

Community

The next category I identified in the literature is 'community' as an umbrella for **social support** and **sense of belonging** as mechanisms underlying the health benefits of urban agriculture. Where the category 'empowerment' focused on the individual, this category focuses on the interactions between participants in urban agriculture and the benefits resulting from that.

Social support

The majority of the articles describing the impact of urban agriculture on the experienced social support of its participants, describe a positive relation. Audate et al. (2019) claim in their literature review synthesis that gardeners in urban agriculture have higher social support than non-gardeners. Nordh et al. (2016) reported that reoccurring chats over the garden fences, developed into friendships between plot holders in allotment gardening and the visitors of the allotment garden, resulting in increased feelings of social support. Moreover, Milligan et al. (2004) reported that the social contact gained through allotment gardening is used for social support as it functions as a buffer against stress, hereby improving overall health and wellbeing. Nevertheless, Hawkins et al. (2011) did not find an significant higher experienced social support for participants of allotment gardening, compared to non-participants.

As the majority of the articles reports a positive impact of urban agriculture on social support, I decided that it should be part of the mechanisms included in the framework. However, the studies reporting social support as a mechanism are focused on allotment gardens. Thus, the generalizability for other typologies of urban agriculture should be considered.

Sense of community

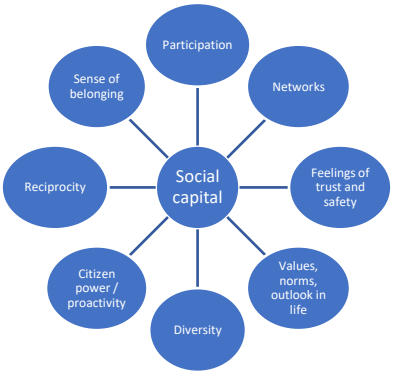

Figure 12 Overview concepts leading to social capital, adapted from Halpern, David (2005). Social capital. Cambridge: Polity Press

In the first place, the second underlying mechanisms identified in the community category was meant to be called social, as the literature refers to sub-mechanisms that are part of social capital (figure 13). However, after I consulted others to test the comprehensibility, it became clear that this term was not self explanatory enough and needed elaboration before it was understood properly. Therefore, I chose sense of community as term to reflect the strengthening of capabilities from participants due to the feeling of being part of the community.

Looking at sense of community in general, Booth et al. (2018) reported that regular and occasional participants in community gardening experienced increased sense of community.

Increased **participation** was reported by Litt et al. (2015), they found that both community garden and home garden participation increases involvement in activities. Subsequently, leading to an increase of collective efficacy. More over, urban gardeners were reported to be more involved in social activities than non-gardeners (Litt et al. 2015).

Furthermore, gardens tent to help with social network building as they facilitate involvement in community life (Alaimo et al. 2010) and **networks** are strengthened by agriculture in this way. The feeling of social cohesion in these networks is improved through food sharing by participants in urban farming (Gasparatos, 2020)

Feelings of trust and **shared values and norms** are underlying to collective efficacy and are used to intervene for the common good (Litt et al. 2015). Collective efficacy is driven by social cohesion, that was statistically demonstrated by Soga et al. (2017) to be experienced to a higher extent by gardeners than non-gardeners.

Further more, Firth, Maye and Pearson (2011) describe that a community garden provides a space where community gardeners with a **diversity** of backgrounds can communicate with each other, share experiences, bond with each other and learn from each other.

Further related to building social capital is the opportunity for community members to work towards a common goal in setting up and running a garden (Teig et al. 2009). In this way **citizen power** is stimulated, thus potentially strengthening the social connections in neighbourhoods (Teig et al. 2009).

Lastly, urban gardens provide an opportunity to set a basis for reciprocity between the individual and the community (Hale et al. 2011) and contribute to sense of community in that way.

Context

The last identified category from the literature is 'context'. This category consists of **participation level**, **population** and **active/passive use**; factors that could influence the mechanisms underlying health benefits of urban agriculture and the extent of the health benefits. Therefore, context is place outside of the framework as force from outside, influencing the outcomes of the framework.

Participation level

One of the categories described in the literature to be of influence on the outcomes of the framework is the level of participation in urban agriculture. However, the evidence in this area is contradicting and will be elaborated upon in the following paragraph.

On the one hand Shanahan et al. (2016) and Aerts et al. (2018) describe that duration and timing of the interaction with green environments, whether it is natural or man-made, determine the physical and mental health benefits associated with this interaction. Furthermore, Booth et al. (2018) state that the level op participation in gardening activities should be considered, because some outcomes are only obtained on higher participation levels.

On the other hand, Hawkins et al. (2013) as well as Mead et al. (2021) state that the exposure to urban agriculture has the same benefits to wellbeing than engagement in urban agriculture. Mead et al. (2021) consider this as an important aspect to take into account as there are more people proximal to urban agriculture compared with those that are directly engaged. If the health benefits of urban agriculture are conferred with proximity, this has implications for urban agriculture as a mean to improve health. Nevertheless, research into the combined effect of proximity and engagement on the health benefits of urban agriculture has not been researched yet (Mead et al. 2021).

Passive/active use

There are several ways to "use" urban agriculture. Some people might only visit a community garden to sit down and enjoy the view of the garden, while others work in the garden itself. This distinction between active and passive use of urban agriculture is another category described in the literature to influence the extent to which the health benefits of urban agriculture apply. Holt et al. (2019) showed that passive interaction with green space was not strongly associated with health and well-being indicators. The same study showed, that frequent active engagement was associated with a better overall mood, lower perceived stress, and a higher perceived quality of life (Holt et al. 2019). This implicates that the way in which is participated in urban agriculture, might impact the health benefits derived form urban agriculture.

Specific target groups

The majority of the articles had participating adults as their research population. However, in 36% of the selected articles a specific group was targeted. Specific conditions of participants might influence the health benefits derived from urban agriculture. The other way around, the needs and motivations to engage in urban agriculture of these participants might also differ from adults as a general group described in the dominant literature. Therefore, 'specific target groups' is chosen as a mechanism influencing the framework. In the following paragraphs, the specific research populations identified in the literature are described.

Literature specifically targeting **children** describes the effect of several types of urban agriculture on F&V consumption (Savoie-Roskos, Wengreen, and Durward 2017) and a broader range of benefits coming from school gardens (Ohly et al. 2016). The main benefits from school gardens reported by Ohly et al. (2016) was in qualitative research for the group pupils who generally do not excel in classroom activities. The effect of school gardens on fruit and vegetable intake was limited and based on self-report (Ohly et al. 2016). However, when looking at different urban agriculture types, a statistically significant increase in fruit and vegetable consumption is reported among children participating in urban agriculture initiatives (Savoie-Roskos et al. 2017). In line

with Ohly et al. (2016), Savoie-Roskos et al. (2017) also report on limitations in study designs because of conveniences samples, self-reported measurements and small sample sizes.

For urban agriculture initiatives targeting children, the lifestyle category and specifically F&V consumption might have a greater importance than in the general population referred to in the dominant literature.

Another specific target group described in the literature are **refugees** and how they benefit from urban agriculture. Both studies focussing on refugees in the literature research (Gerber et al. 2017; Hartwig and Mason 2016) where targeting on the effect of community gardens specifically as part of urban agriculture. Even though Gerber et al. (2017), show that the quantitative effect of the community garden on symptoms of depression, anxiety, somatic complaints or adjustment to a new life for refugees turned out not significant, the benefits of community gardening on experienced social support was significant (Gerber et al. 2017). This was supported by qualitative data showing the role of social support in community gardening. Additionally, Hartwig and Mason (2016), reported an increase in vegetable intake as benefit of community gardening for refugees and improved sense of identity with their former selves. Even though Gerber et al. (2017), did not find a significant decrease in symptoms of depression and anxiety, focus groups in Hartwig and Mason (2016) indicated the garden as a healing space for depression or anxiety. Both articles conclude that gardens have the potential to serve as a meaningful health promoting tool for refugees.

Nevertheless, more research with bigger samples is needed to investigate whether these benefits apply in other settings. Concerning the development of the framework, no new topics appear from this part of the literature focussing on refugees. Though, the community category might be of greater importance for this target group as well as the empowerment category. Both of these categories were supported by evidence from all the articles focussing on this specific target group.

As urban agriculture is often associated with mental health benefits, part of the literature focusses on a research population with predetermined **metal conditions.** Examples of these mental conditions are mental and intellectual disabilities (Dewi et al. 2017; M J Suto et al. 2021; Triguero-Mas et al. 2020) and developmental disorder like an autism spectrum disorder (Scartazza et al. 2020).

For the later, working on the development of a healing garden showed to be an effective way to promote agro-biodiversity as well as rehabilitative objectives effectiveness in the participants. Specifically, social skills and interpersonal relations significantly improved through participation in management of the healing garden (Scartazza et al. 2020). Suto et al. (2021)investigated the effect of community gardening on wellbeing for people living with mental health issues in supported housing. They found that the community garden increase wellbeing through welcoming places, a sense of belonging and development of positive feelings. Specifically, the interaction and connection with living things and responsibility for the plants offered participants an opportunity to learn about gardening and themselves. Moreover, it grounded participants in the present (Suto et al., 2021).

On top of that, the benefits of rooftop gardening were investigated for participants with intellectual disabilities and mental disorders (Triguero-Mas et al. 2020). Urban rooftop gardening turned out to be associated with increased personal development and suggested enhanced physical and emotional wellbeing, sense of purpose, social inclusion and interpersonal relations. For people with intellectual disabilities and mental disorders the general quality of life enhanced through rooftop gardening.

However, an appropriate workload allocation in urban agriculture for this group of participants with predetermined mental conditions is necessary because reducing the intensity of work assignments for people with mental

disabilities reduces physical stress (Dewi et al. 2017). Compared to the control group without mental disabilities Dewi et al. (2017) found significantly lower increase of the ratio of the hart rate (IRHR) during low-intensity work, but significantly higher IRHR levels during high-intensity work in participants with mental disabilities. Additionally, the participants with mental disabilities had significantly higher levels of fatigue during high-intensity work like digging and turning over soil, than during the rest condition. This emphasises the importance of proper workload allocation for this target group.

The research population with mental conditions is researched in the biggest diversity of urban agriculture typologies in this literature review (rooftop farming, community gardening and healing garden). Especially, rooftop farming and healing gardens are underrepresented in the literature. Nevertheless, the other typologies are lacking in the literature and therefore, a complete overview of benefits of urban agriculture for people with mental disabilities cannot be made. However, this small sample suggests that mainly interpersonal relations and social skills are strengthened, as well as physical and mental wellbeing through a sense of belonging and purpose. This might implicate that the community and empowerment box in the framework should be weighted more than the other boxes for this group of participants. Furthermore, workload allocation might be added as a barrier for this participant group.

One article in the literature search focussed on the role of community-based urban farming for participants diagnosed with **HIV** (Shacham et al. 2012). Despite an lack of significant changes, the qualitative research showed that participants experienced less distress symptoms, reduced frequency of illicit drug use and improved overall general health (Shacham et al. 2012). Nevertheless, more research on a larger scale is needed to provide more robust evidence on the benefits of urban agriculture for this specific participant group diagnosed with HIV.

An relatively often research population are **vulnerable communities**, examples of these vulnerable communities are minorities, immigrants indigenous communities and socio-economic disadvantaged groups (Malberg et al., 2020)These groups have in common that they are disproportionally affected by chronic diseases like obesity and diabetes (Mangadu et al. 2017; Ornelas et al. 2017, 2018). In general, the reported health benefits from urban agriculture in for vulnerable communities do not deviate from the mechanism described before in this thesis. For the Navajo nation, the largest Indigenous tribe in the US, urban agriculture is shown to help with increased nutrient consumption, increased physical activity, decreased expenditures on food and increased mental wellness (Brown et al. 2020; Lombard et al. 2006).

Especially F&V consumption increases are reported for vulnerable communities in the literature (Algert et al., 2016; Carney et al., 2012; Ornelas et al., 2017). However, Malberg et al. (2020) mention that the literature is inconsistent about the influence of urban agriculture participation on food security. This might implicate that despite the F&V consumption increase, food security might not necessarily go up.

Next to F&V consumption, Weltin & Lavin (2012) researched the Haemoglobin A1c (HgA1c) levels of immigrated participants of urban agriculture with measures before involvement in the initiative and after the intervention. Testing the HgA1c level is a simple blood test that measures average blood sugar levels of the previous weeks. High HgA1c levels are a predictor for risk of diabetes type 1 and 2. Weltin & Lavin (2012) found that persons who participated in urban agriculture had a significant reduction in HgA1c levels after the intervention, compared to persons who did not participate actively. This kind of quantitative investigation of the effect of urban agriculture on HgA1c levels was not present in the literature for other research populations. Therefore, this cannot be compared or generalized to non-immigrants. However, the

mechanisms described to explain the differences in the paper of Weltin & Lavin (2012), are comparable to the mechanisms described previously in this thesis (improved dietary intake and increased physical activity). Even though the health benefits of urban agriculture in these vulnerable communities were previously discussed for participants in general, the impact of these benefits might differ. For example, if a community experiences a disproportional high risk of diabetes due to health behaviour related reasons, the relative benefit of reduction of HgA1c is higher.

Furthermore, elderly is also a research population mentioned in the literature (N=3). There is some unclarity in the definition of elderly, Milligan et al. (2004) and Nicholas et al. (2019) categorized everyone above 60 years old as elderly, whilst Martens et al. (2018) took 62 year old as definition of elderly. For purposes of clarity, the articles focussing on people above 60 years old will be included in this part. In the literature describes three main beneficial categories of urban agriculture: social, restorative and reminiscence experiences (Martens, Nordh, and Gonzalez 2018). Nicholas et al. (2019) described significant pre-post improvements in quality of life, experienced anxiety, levels of depression, social relations, physical effects and cognitive effects for this research population. Especially in long-term care facilities, the benefits of urban agriculture are substantial (Nicholas, Giang, and Yap 2019). Urban agriculture can provide elderly with a supportive environment to combat social isolation and increases sense of achievement, satisfaction an aesthetic pleasure (Milligan, Gatrell, and Bingley 2004). In that way, urban agriculture can function as a therapeutic space for elderly.

Other articles focus specifically on elderly diagnosed with **dementia** (Marsh et al. 2018; Nicholas et al. 2019; Zhao et al. 2020). Participation in horticultural activities was shown in a meta-analysis to significantly increase scores for cognitive functioning, agitation, positive emotion and engagement (Zhao et al. 2020).

These benefits of urban agriculture for people diagnosed with dementia might be explained by a dementia-inclusive environment provided in urban agricultural initiatives. According to Marsh et al., urban agriculture can provide a place that allows for positive risk-taking opportunities, respectful intersubjectivity and active citizenship (Marsh et al. 2018). However, active engagement in urban agriculture is required to experience benefits of urban agriculture for people diagnosed with dementia (Marsh et al. 2018; Nicholas et al. 2019).

3.4 Validating the outcomes

In the following paragraph, I will describe the outcomes of the conducted semi-structured interviews. The paragraph aims to validate the outcomes of the systematic literature review and to assess whether the outcomes investigated in a certain type of urban agriculture are generalizable to other (less investigated) typologies. Furthermore, the comprehensibility and value of the framework were tested to answer the final research question: "What is a possible graphical representation of the mechanisms underlying the health benefits of urban agriculture?". Firstly, the outcomes per framework category are discussed. Second of all, the feedback on the design and perceived value of the framework are discussed, as well as the implications the feedback has for the framework. Lastly, a conclusion is drawn based on the conducted interviews.

Urban green

Under 'urban green' I categorized all comments related to being outside and seeing green, that were not specifically related to urban agriculture. These comments relate to the 'green' category in the framework. None of the participants questioned the benefits of being outside for your health. Especially, mental health benefits were mentioned in relation to being outside.

"Being active outside, settling down, handline with, with setbacks. It is never, it [nature] can not be forced right? […] So, So I think that nature and growing vegetables has a value for everyone's health" [1]

Just being outside was assumed to be healthier by default than sitting inside. Most participants could not give an explanation why being outside was healthier but were strongly convinced it was healthier. Just seeing and being in a green surrounding was perceived as a healthy setting. Likewise, climate regulation was not always mentioned by the participants, but participants agreed that it should be in the framework. Some participants remarked after seeing the framework, that they did not mention the climate before as they assumed it was so obvious that they forgot to mention it

However, one participant mentioned that she was not so sure about her impact on climate regulation. She said that her impact was probably so small that she would not put it in the framework. Nevertheless, all other participants recognized it as an important mechanism and for some it was a strong motivation to participate in urban agriculture.

"Climate change, I find that always difficult […] the limited influence that I can have on that. With the small part that I manage, I cannot expect wonders from that. So, climate change is more something we live with and adapt to, than that we loudly scream that we are the solution." [2]

Biodiversity was not mentioned by the participants before seeing the framework. Nevertheless, they agreed with biodiversity as a described mechanisms in the framework. It was mentioned that biodiversity in urban agriculture is often much higher than other forms of urban green. Moreover, urban agriculture gives the freedom to choose your own preferred species, which is often not possible in urban green.

Lifestyle

Under the category 'lifestyle', vegetable consumption and physical activity were topics that were often mentioned by the interviewees before seeing the framework itself. Interviewees mentioned that they ate more vegetables, but also different vegetables since they participated in urban agriculture. Several interviewees mentioned explicitly that they grow different species that are unavailable in the supermarket. Varying from different colours of tomato to ancient varieties of certain crops.

"And you can really taste the difference in a tomato that's grown in the sun versus something that's grown in the greenhouse. It's completely different. So, it's just better, it's just better. And the type of crops that you can grow as well is

completely different. It's what you want versus the limited variety that you can get from a supermarket." [3]

Also, one commercial urban arable farmer mentioned that the taste of their products is better and that the taste of their products was the reason people eat more of it. Furthermore, she increased the number of vegetables in their pre-made dishes to make sure that consumers of her urban farm eat vegetables well above the recommended levels of the Dutch Centre for Nutrition (Voedingscentrum).

In one of the social urban agriculture initiatives, most participants were passively engaged by just visiting the place and having a chat. The interviewee from this initiative questioned if she ate more vegetables herself due to the garden, because she liked vegetables before too. However, she was convinced that the passive participants ate more vegetables because of the initiative. Several of these passive participants walked to the garden twice a week to get fresh products. Going to the initiative does not only increase their F&V intake, but also their physical activity. Most of these participants have physical or mental health challenges and go to the garden for "gezelligheid": some one to talk with. On top of that, the participant mentioned that they leave their houses and go for a walk to get there and increase physical activity as side effect.

All participants told me in one way or the other that their physical activity increased due to participation in urban agriculture. Moreover, several interviewees explained that physical activity in urban agriculture is different than, for example, walking in a green environment. As walk in the park does not give you the same feelings of accomplishment as working in urban agriculture.

"I think there [urban green] it's more meditative, if you go and you sit on a bench and you look at like a pretty flower scene in a garden. It's nice, we walk around it, but there you're missing the active aspect of being involved." [4]

Furthermore, growing vegetables and fruits ask for commitment to go regularly, which is not the case if you go for a walk. A participant called weeding a meditative exercise, but also a way to train your body.

"Weeding which is like a very mindful thing and even if it's only for 20 or 30 minutes, it's, you feel completely different afterwards. So that's the first thing. Secondly, obviously physically you're doing a bit of physical effort when you're in the garden. Squatting down and pulling weeds and planting whatever, hewing, anything that you do out here. It's physically work that you do." [5]

Nevertheless, the high physical activity needed to engage actively in urban agriculture might also be a barrier to participate. An employee of a commercial urban farm described the hard time she had when she started the job. The physical demand of the work was too high for her to work the hours she wanted. Therefore, she needed a transition period to get used to the physical demand.

"In March [I started working], beginning of Marc hand from that moment on gradually more and more. Adding one day at a time. Also, to build up the physical part a bit. And only last month, [I worked] four days [a week] and then I backtracked pretty quickly, because I thought: no this really, this just does not work." [6]

Empowerment

In general, all interviewees agreed that the category empowerment belonged in the framework and is a mechanism that explains health benefits of urban agriculture. In the first part of the interview, where they were asked to describe the benefits of urban agriculture was for them, aspects were mentioned that belonged in the category 'empowerment'. Especially the educational and personal development aspect of urban agriculture was often mentioned in the interviews.

The economic mechanism was less often described by the interviewees. It was mentioned that participants saved money on vegetables, since they did not have to buy them in the

supermarket anymore. However, one interviewee mentioned that she was not sure about the savings made from it, as she spent the money first on equipment to grow the vegetables. Furthermore, an indirect mechanism was described by a few interviewees, related to their ability to participate in job interviews successfully due to an increase in self confidence and skills. This is in line with an observation of Kirby et al. (), that gaining employment skills should be part op the economic factors affected by urban agriculture, but currently disappears as a benefit under 'education'.

"Yes, economically. Look other things do play a role within that [economics]. In that sense. Because if you grow from this [initiative], just as a person, you get things out of that which you can apply to other things through which you might benefit economically as well." [7]

One interviewee, running a commercial urban arable farm, mentioned that she did not recognize empowerment to a high extent as a benefit of urban agriculture. She mentioned that participants (customers) merely benefit from empowerment in urban agriculture if they want to learn about the food and the education aspect is touched upon in that way. She did not recognize personal development and economic mechanisms as a benefit for her customers. Nevertheless, the other interviews recognized the emancipating effect of urban agriculture and two interviewees mentioned most important mechanism in their opinion.

"It [urban agriculture] is very empowering in that sense, because what is more empowering than having influence on your own health, the greatest good that we eventually have. So, creating an environment in which you can support those things, that is for me the most empowering thing you can do." [8]

Community

In the first part of the interviews, where interviewees named their own perceived benefits of urban agriculture without having seen the framework, community was a strong and often mentioned benefit form urban agriculture.

Participants generally reported the feeling of connection to the other participants in their initiative. Especially in initiatives where participants joined the initiative because of past experiences or personal circumstances (e.g., mental health conditions, chronic diseases etc), participants were likely to talk openly about their story. By sharing their story, they felt supported by others who were willing to listen to their story. Besides, the initiatives allowed for other topics to talk about, which offers an opportunity to forget challenges of daily life for a moment. Working in the initiative gave the possibility to connect with others based on the participation, instead of being seen as someone who is 'sick' or 'different'.

Moreover, it was mentioned that they help each other out if challenges are discussed. One participant told me about fellow allotment gardeners for who she did the groceries during the first phase of the COVID-19 pandemic. She mentioned another example on how she and another participant helped each other out during their holidays.

"So, if my friend was on holiday, I would go and water her garden. If I was on, she would water mine. We have a trade off, just to help each other and then also at the same time, we have like cookouts with our harvest, which is super fun. But we try to grow different things in our plots, so we can try each other's food and that's also really, it's a really nice experience." [9]

No line was drawn between the community category and physical health, because the literature did not support the connection between physical health and communal mechanisms. However, a participant mentioned to have examples of ways in which the community mechanisms have an impact on physical health.

"I think that you could think of a line between all these things. If I think about community and physical, maybe it is more an indirect line, but

you notice that people instigate each other to go to these kinds of places and that [..] people take care of each other […] and that they sort of take better care of themselves and that people tell each other to take better care of themselves. But that is an indirect way." [10]

A difference that was noted was the reported community related comments between the commercial urban arable farmers (employee and employer) and the other participants. The commercial urban farmers recognized less social health related outcomes and did not mention community related mechanisms in the first place. An explanation for this observation might be that people outside of the initiative are only involved in buying products from them, they are not engaged in running the initiative in other ways. However, these participants mentioned a few social related benefits, like an example of social contact and control among customers.

"That social aspect is important to people, I think. [..] You have someone to talk with [in the line] and you do not have that at Jumbo [big supermarket]. For example, [name] an old costumer who is far in her 80's, but she is here two times a week. But if she does not show up, you call her, or I ask my children to pass by [to bring the groceries]. That is actually all part of it." [11]

On top of that, it was mentioned that urban agriculture does not only affect the people engaged in the project itself. Two participants mentioned that it also, influenced social health of the local community. By being present at the initiative on set times and days, people from the community pass by for a talk every time someone is present. Some even get involved in the project in that way, even if they are not active in the garden itself.

"It like the people you are talking with. They actually never do something in that garden, but you do have a lot of contact with them. That is something that arises from the garden, you know. […] Some people come to you to give a cup of beer and tell you to put that in the soil against the snails […]. For him is that social and he feels himself useful and it gives satisfaction if you help each other in that way." [12]

Design

After discussing the mechanisms described in the framework, there was consensus about the content of the framework. Thus, the findings of the systematic literature review were validated by the participants of urban agriculture included in this thesis. However, there were multiple remarks about the design and layout of the framework. One participant summarized his reservations with *"Oh this? This is aesthetically unattractive sorry".* [13]

Most often commented on was the linear shape of the framework. The linear shape was not perceived as a right representation of how urban agriculture influences health outcomes. The linearity suggests that there is a one-way relation between the boxes, whilst a one-way relation was not recognized by the participants. Health status might influence participation in urban agriculture and could be a starting point instead of an outcome. Similarly, boxes in the middle of the framework could be interrelated, amplifying or diminishing outcomes in this way. The possible interrelation of mechanisms is in contrast with the current framework design, where mechanisms are visualized as parallels which are not connected to other mechanisms. Therefore, a circle shape was proposed by several participants. On top of that, colour differentiation was recommended between the boxes of the framework to distinguish between the categories.

Moreover, the division between physical, mental and social health was not evaluated positively. The division of health outcomes did not reflect the interconnected view on health and health outcomes of the participants in urban agriculture. The participants came back to the idea that health should be considered from a holistic perspective and that the different health types maintain and influence each other. Some mentioned that a line between the types of health would be sufficient solution. Others would like to add spiritual health or preferred a

circle around the health outcomes reflecting general wellbeing. None of the participants came up with the same solution. However, there was a consensus that the division between the several types of health was disliked by the majority of the participant. Nevertheless, one participant mentioned that it prevents the reader of falling into the trap of seeing health as merely physical health. Therefore, social and mental health should be mentioned in the framework according to this participant.

Furthermore, the starting point of the framework was perceived as unsuitable. Currently, the framework should be read from left to right, which could imply causal relations and one-way interactions. Some participants did not agree with the starting point, as it could suggest that one box is leading to the other, while a reciprocal relation might be possible. Additionally, urban agriculture is visualized in the framework as the main driver for the derived health benefits. It was mentioned by participants that not only the type of urban agriculture influences the health outcomes of urban agriculture, individual values and aims play a roll as well. Therefore, the individual should be the centre of the framework according to some participants.

"It is all connected with each other, but the question is what you would put in the middle. […] I would do it the other way around. Starting from health and which factors do you have to take into account to reach that and how are you going to do that. […] the business is not central, eventually your family is the central point." [14]

Despite the criticisms and feedback derived from the interviews, some participants appreciated the framework for research purposes. Since the framework has clear structures and components, it was mentioned to open up dialogue in academia. Moreover, it shows the knowledge gaps as a starting point for further research.

Value

The participants were questioned about the value of the framework and in which situation the framework could be of value. Findings reveal that there were two situations where the framework could be of value, according to the participants. Firstly, the framework could be used to show the community around the urban agriculture initiative the benefits of the initiative in their surrounding. In this way, support from the community could be increased. Increasing community support was mentioned to be of paramount importance as several initiatives are depending on subsidies and have to convince policy makers of the value of their project. It is helpful if the community supports them in the application process. The other way around, participants mentioned that the framework could function as a tool to convince policy makers of the importance of urban agriculture. They would use the framework in subsidy requests and to advocate for an increase of space reserved for urban agriculture.

"Because I'm also like kind of, I'm really in support of having more of these and a model like this could help to, you know if I were to approach the local municipality about it, to show them these are the impacts that urban agriculture has on, potentially can have on your local community." [15]

Conclusion

There is a need for a redesign of the current framework, if the aim is to broaden from usable for research purposes towards usability for a broader audience. Overall, the content of the framework was validated by the participants. However, the design was considered to be unattractive and did not reflect the perspective of the majority of the participants. Therefore, a redesign of the framework was conducted based on the feedback of the urban agriculture participants.

Chapter 4: Discussion & Conclusion

4. Discussion and conclusion

Currently, the integration of urban agriculture in European policy and practice is lacking, which hampers development of urban agriculture despite described health benefits in literature (EPRS, 2017). Therefore, the EFUA aims to increase knowledge and awareness about potential societal contribution of urban agriculture. Although interest in the potential of urban agriculture for public health has increased, the mechanisms underlying the health benefits of urban agriculture have been researched insufficiently. Therefore, guidance is lacking for participants in and initiators of urban agriculture initiatives to show their direct and indirect societal value to decision-makers.

This study tried to fill these knowledge gaps by providing an overview of the mechanisms underlying the health benefits of urban agriculture based on a systematic literature review. The initiatives active under the term urban agriculture and the reported health benefits from urban agriculture are diverse. Moreover, the systematic literature review showed a diverse set of underlying mechanisms explaining the health benefits of urban agriculture. They were categorized into four main categories: 'lifestyle', 'community', 'empowerment' and 'green', consisting of underlying mechanisms leading to physical, mental and/or social health outcomes. The outcomes of the systematic literature were visualized in a conceptual framework. Additionally, the comprehensibility and recognizability of the framework was tested by means of semi-structured interviews among participants of Dutch urban agriculture initiatives. The collected feedback from the interviews resulted in a phase of redesigning the framework.

4.1 Redesign of the framework

Overall, feedback collected in the interviews showed that the content of the framework matched the outlook of the participants. Nevertheless, the design of the conceptual framework was less appreciated. The phase of redesign started with feedback from the interviews. The design related remarks in the interviews were all in the same code and formed the start for the redesign.

Especially the linearity of the conceptual framework, did not reflect the interconnectedness between the concepts perceived and the holistic view on health the participants had. Moreover, the connection and interconnectedness between elements was not represented in the conceptual framework according to the participants. Additionally, it was suggested to take the individual as a starting point, who shapes the health outcomes of an initiatives together with the context of the individual and initiative. Based on this feedback and a suggestion of one of the respondents to use the 'Rainbow model', which refers to the model of Dahlgren and Whitehead (1991), led to a redesign based on the model of health determinants (Dahlgren and Whitehead 1991) as shown in figure 13.

Visualising scientific outcomes with complex interrelations is more often described as challenging in the literature. For example, Egli et al. (2016) used a tree shape to visualize their findings from a literature review focussed on community gardening in New Zealand. However, challenges in space allocation of concepts, resulted in a disconnection between 'nature contact' and 'decreased stress'. These concepts ended up both on the other side of the tree, while the literature shows a relation between these two concepts (Egli et al. 2016). Practical implications might complicate suitable visualisation interrelated concepts, leading to a different interpretation by the public than intended. In this thesis, I tried to prevent this issue by the use of the holistic multi layer model of Dahlgren and Whitehead (1991) where interrelation of concepts influences health outcomes together.

In the redesign, the same mechanisms are visible as in the conceptual framework. However, the categories developed (lifestyle, community, empowerment & green) were replaced in the redesign, because the titles from the Dahlgren & Whitehead model were suitable. Especially, as the categories used in the Dahlgren and Whitehead model show the multilevel responsibility for public health (Dahlgren and Whitehead 2021). Likewise, the separated categories of health (physical, social & mental) were removed from the framework since participants did not recognize this separation and preferred an integrated conceptualization of health. Moreover, it was mentioned several times in the interviews that all category boxes should be linked to all health outcomes as they were all connected. Thus, removing the distinction between the types of health outcomes seemed to make more sense.

The Dahlgren and Whitehead model provides a holistic and relatively simple visualisation of the main determinants of health. The model is especially helpful to encourage people outside of the health sector to think about wider social determinants of health in local environments and society (Dahlgren and Whitehead 2021).

The Dahlgren & Whitehead model showed to be particularly interesting for these policymakers and professionals operating in diverse sectors outside the health sectors. The model encourages them to consider what they can do from their own domain to influence health of the population they serve (Dahlgren and Whitehead 2021).

This is interesting for urban agricultural initiatives, as policy makers typically responsible for these initiatives are often not related to the health sector despite the potential of urban agriculture for the health promotion. Here, the model can provide a foundation to encourage people from different sectors to work together on a common goal as the different sectors get ownership and responsibility over their impact on public health (Dahlgren and Whitehead 2021).

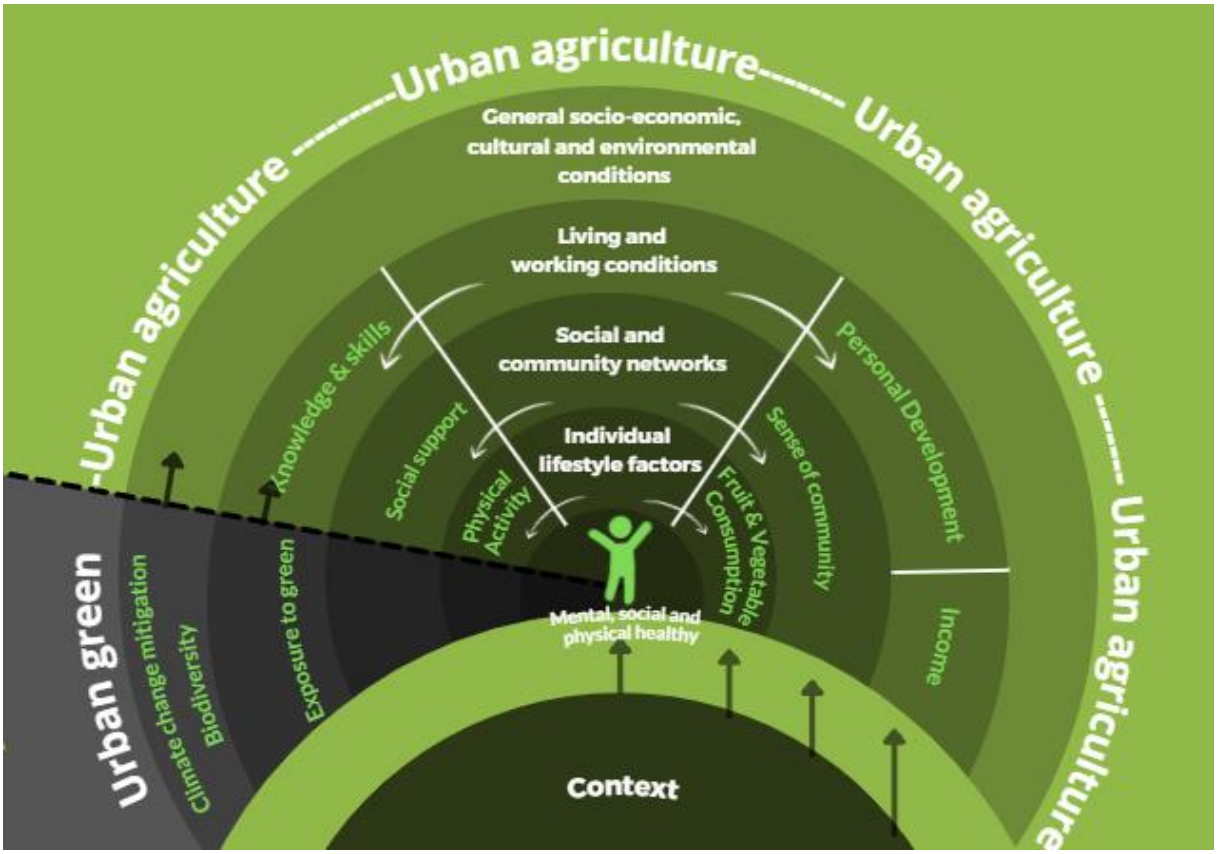

Figure 13 Redesign of the framework visualizing the mechanisms underlying the health benefits of urban agriculture, adapted from Dahlgren & Whitehead (1991)

Besides the applicability of the Dahlgren and Whitehead model for the visualisation of the systematic literature reviews outcomes, it received criticism. The main criticism being that the model is useless as an analytic tool for empirical testing of causal pathways (Dahlgren and Whitehead 2021). However, showing causal pathways was not the purpose of the model and it is only meant to visualize the main determinants of the health of populations to show the different interconnected layers of influence (Dahlgren and Whitehead 2021). Therefore, I would propose to build upon the conceptual framework in this thesis for purposes of empirical testing of casualisation between concepts and not upon the second redesigned model, since Dahlgren & Whitehead state that their model is not suitable for these purposes (Dahlgren and Whitehead 2021). Thus, the first and second framework can co-exist as they both serve a different type of research. The first model might fit better for quantitative hypothesis and causality testing, but the redesign based on the Dahlgren & Whitehead model fits better for qualitative research building upon the interrelatedness of the concepts. Also, the redesign based on the Dahlgren & Whitehead model fits better for communication and policy purposes to get different sectors together (Dahlgren and Whitehead 2021).

This research acknowledged the diversity in urban agriculture initiatives in the form of typologies of urban agriculture Furthermore, diversity within typologies was acknowledged from the start. Especially, as the literature describes the potential differences in health outcomes driven by characteristics of urban agriculture typologies. The current body of literature tends to capture the diversity in urban agriculture by focussing on one typology to ensure that results are generalizable within the typology. However, this results in a tendency in which the outcomes of one typology are usually not compared to other typologies while the mechanisms explaining the results might be applicable to other typologies.

Despite the diversity of typologies and characteristics of initiatives represented in the systematic literature review and interviews, there were merely differences found in the health benefits reported among typologies. Most differences in health benefits derived from urban agricultural initiatives seemed to be explained by contextual and individual factors. Therefore, the outcomes of this thesis suggest that the focus of research should swift from set typologies, like allotment garden and community gardens, towards the overarching characteristics of initiatives, like levels of social contact and level of commercial motivations.

Another point to discuss is the fact that this thesis focussed on the health benefits of urban agriculture. However, urban agriculture does not merely know health benefits, also health risks are discussed in the literature. A point for attention raised is the aspect of social exclusion, based on the observation that urban agriculture can be a place where certain groups of participants might feel excluded. For the reason that urban agriculture can be a place where existing race and social class-based disparities in society are replicated (Audate et al. 2019). In addition to these social health risks, physical health risks are reported. The most prominent raised issues are related to food safety due to urban soil and water contamination (Audate et al. 2019). However, the majority of the articles concerning health risks of urban agriculture are performed in an African setting and most findings do not allow to draw definitive conclusions on the topic as most findings are based on assumptions of the authors about amount of produce consumed and the soil accidentally ingested by the population (Audate et al. 2019; De Miguel et al. 2017).

4.2 Limitations

First of all, the broad range of typologies active under the term urban agriculture was represented in the interviews. Vertical farming and rooftop farming were not included in the research sample as I was not able to get in contact with participants of these types of initiatives. Besides, these typologies were underrepresented in the literature. However, I would argue that this does not mean that these typologies do not have a potential for health benefits. Since the number of these types of initiatives active is still limited in the Netherlands and Europe as a whole, several initiatives reported back that they receive plenty requests to participate in research. However, they do not have the capacity to deal with all these requests and chose the ones most interesting to them. From a short inventory of websites of these types of initiatives, I would argue that they mostly focus on environmental benefits of their initiatives and are therefore less interested in research in health outcomes. This view is supported by the fact that the articles included in the systematic literature review focussing on rooftop farming were all conducted in a hospital setting. Therefore, these cases were specifically interested in health outcomes and, in contrast to the majority of the rooftop farms, not motivated by environmental concerns. Thus, future research is recommended to further investigated the health benefits of underrepresented types of urban agriculture and the mechanisms underlying these health benefits in order to verify the framework.

Secondly, this thesis focussed on the perception of participants in and initiators of urban agriculture initiatives to reflect and give feedback on the framework. Due to time limitations, it was not feasible to include the perspective of policy makers related to the field of urban agriculture. Nevertheless, it would have been interesting to hear their perspective, as the interviewees mentioned that the framework could help them to advocate the importance of urban agriculture to policy makers and subsidy providers. To see if this framework gives policy makers more insight into and a positive attitude towards urban agriculture, further research into this topic is needed.

Thirdly, when focussing on the methodology the limitation to only include peer-reviewed articles makes the outcomes of this thesis susceptible to publication bias (Rosenthal 1979). Studies with negative or neutral results are less likely to be published, which might lead to a less balanced view on the health benefits of urban agriculture. Moreover, the comprehensive process for the systematic literature review by searching through the citations of the found articles, might complicate the replication of the search results.

4.3 Implications and further research

Conveying complex messages are a challenge for public health and graphical models can be useful to achieve this (Egli et al. 2016). This thesis was the first attempt to visualize the diverse benefits of urban agriculture participation to health in a framework suitable for use by participants and initiators of urban agriculture initiatives. In this manner, the framework allows for bottom-up advocacy actions. Nevertheless, visualizing scientific findings and theories for different audiences remains challenging. This statement is supported by the findings in this thesis, showing that a scientific representation of literature does not necessarily match expectation of participation of such a visualisation. Similarly, the requirements of policy makers for a visualisation of scientific outcomes might be different. However, the suitability of the framework for policy purposes was not tested in this thesis and should be further investigated in future research. Furthermore, researchers might prefer the linearity of the conceptual framework, for the purpose of hypothesis testing, whilst the participants in urban agriculture particularly disliked this visualisation. Therefore, guidance in the form of a scientific visualisation roadmap in the interrelated field of public health would benefit targeting these audiences effectively. Nevertheless, additional research dedicated to this topic is needed to develop such a roadmap.

Furthermore, participants questioned repeatedly the possibility to quantify health benefits of urban agriculture, to visualize this with weighted relation in a framework and make this adjustable depending on the initiative. Currently, the body of mostly qualitative literature does not allow to make these kind of quantifications and visualizations. However, social and mental health benefits of urban agriculture might be better captured with qualitative research if complying to quality criteria. To meet the request of participants more mixed methods research is needed after the health benefits of urban agriculture. Moreover, a unified language is needed to deal with heterogeneity between and among different urban agriculture types (Audate et al. 2019). Thus, current attempts like the EFUA project to capture the diversity of urban agriculture in a renewed typology might be a step in the direction of a unified language across urban agriculture in Europe.

4.4 Conclusion

In conclusion, this study contributes to our understanding of the mechanism underlying the health benefits of urban agriculture. Additionally, it provides an overview of the underlying mechanisms through the developed framework. Four categories of underlying mechanisms were found: lifestyle, community, empowerment and green, which were described to a varying extent per type of urban agriculture. The first framework visualizing the outcomes was validated by participants of urban agriculture and the content was recognized and agreed upon. However, the design was unappealing and needed a redesign to become more appropriate to meet needs of urban agriculture participants. These insights form aid to EFUA aims by increased understanding of the mechanisms underlying urban agriculture potential for health promotion. Furthermore, awareness might increase for the health benefitting potential of urban agriculture through the developed framework that allows for bottom-up advocacy actions by participants. Future research is recommended to test generalizability of the framework for underrepresented types of urban agriculture and potential of the framework among a broader range of stakeholders.


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Appendices

Appendix I: Characteristics interviewees

	Gender	Type of urban agriculture	Role in initiative
1	Male	Edible campus garden	Project leader (voluntary)
2	Female	Allotment garden	Plot owner
3	Female	Community garden	Project leader (paid)
4	Female	Urban farm	Employee
5	Male	Community garden	Project leader
6	Female	Community garden	Volunteer
7	Female	Urban farm	Owner
8	Female	Community garden & school garden	Board member
9	Male	Allotment garden	Plot owner

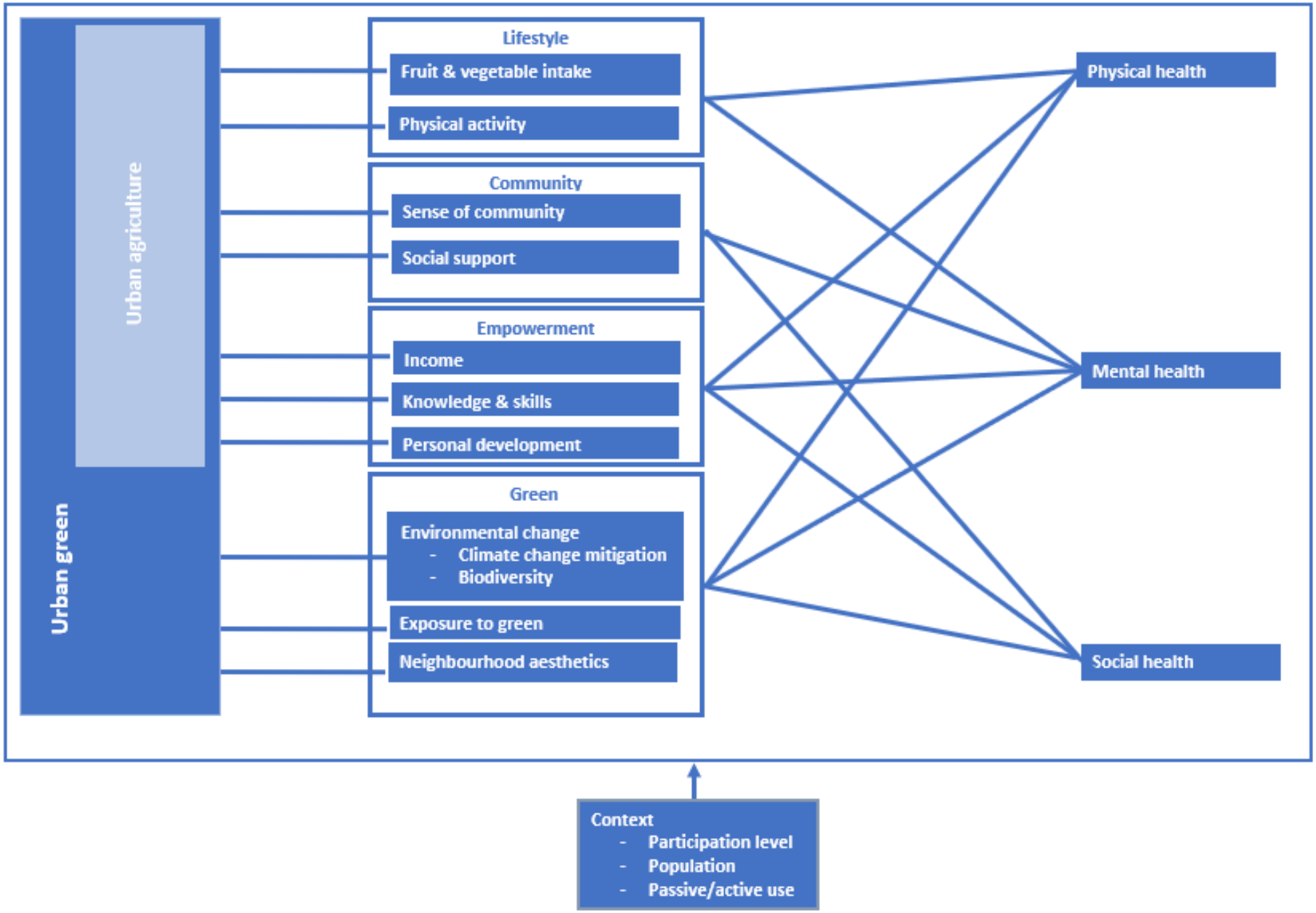
Appendix II: Typology sheet filled in for interview initiatives

	City	Country	Preliminary type	Type of product																		
				Food							Non-food		Services (non ecosystem~)							Ecosystem services		
				Animal products				Plant-based products														
				Meats	Milk & eggs	Fish	Honey	Fruits, vegs, potatoes, grains (commodity products)	Mushrooms	Herbs	Medicinal plants	Flowers	Education	Leisure	Healthcare	Circularity	Social cohesion	Cultural heritage	Biodiversity	Soil conservation	Water retention
1	Rotterdam	Netherlands	Edible campus garden	.	.	.	x	x	.	x	.	x	x	x	.	x	x	.	x	.	.
2	Haarlem	Netherlands	Allotment garden Home garden	.	x	.	.	x	.	x	.	x	.	x	.	.	x	.	x	.	.
3	Goor	Netherlands	Community garden	.	.	.	x	x	.	x	.	x	x	x	x	.	x	.	x	x	.
4	Amsterdam	Netherlands	Commercial urban farm	.	.	.	.	x	.	x	.	.	.	.	.	x	.	.	x	.	.
5	Emmen	Netherlands	Community garden	.	.	.	x	x	x	x	.	x	x	x	x	x	x	.	x	.	.
6	Cuijk	Netherlands	Allotment garden	.	.	.	.	x	.	x	.	x	.	x	.	x	x	.	x	.	.
7	Zoetermeer	Netherlands	Community garden School garden	.	.	.	x	x	.	x	.	x	x	x	.	.	x	x	x	.	.
8	Harderwijk	Netherlands	Commercial urban farm	.	.	.	x	x	.	x	.	x	x	.	.	x	x	.	x	.	.

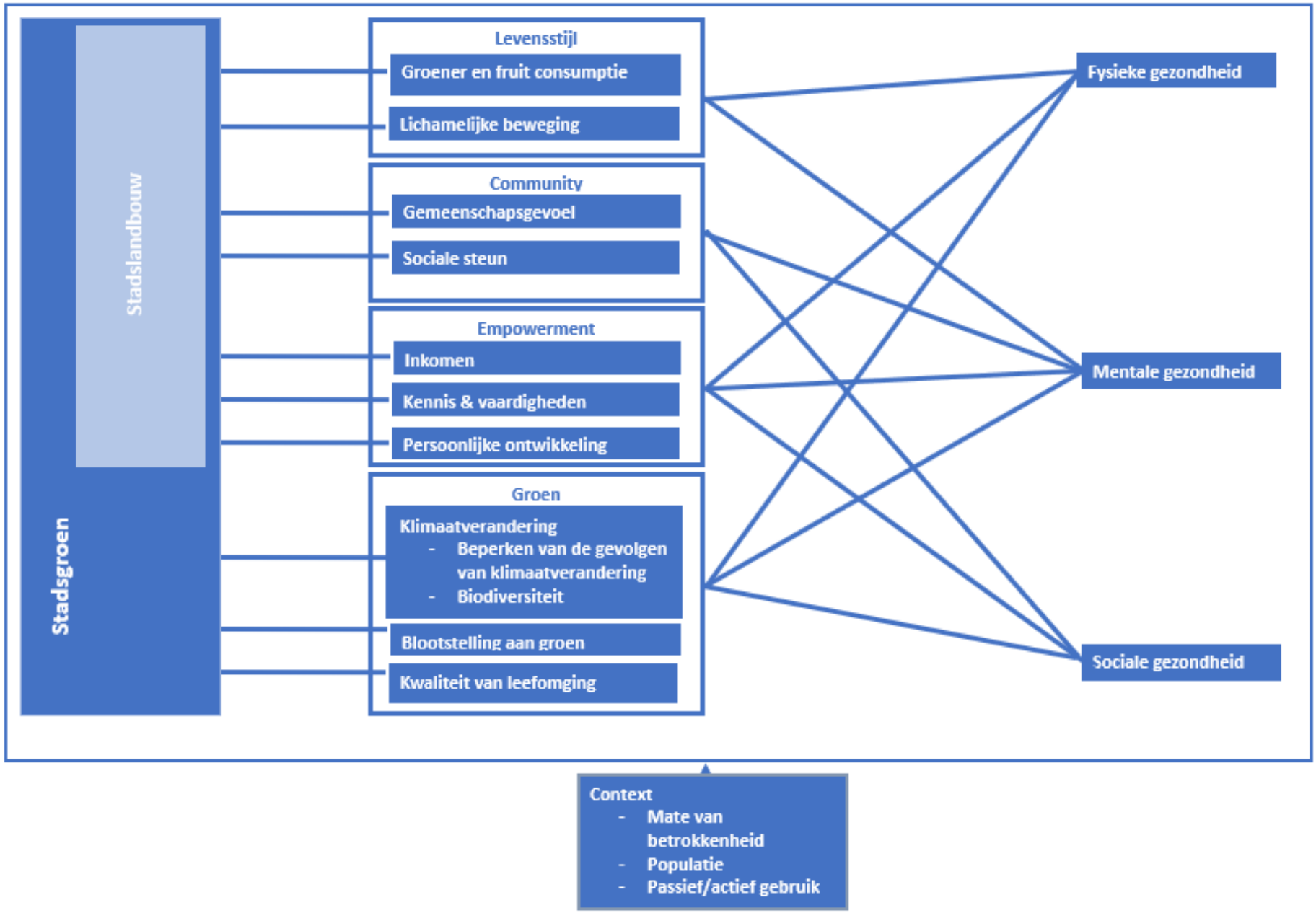
	Product destination (who 'consumes' it?)									Location																					
	Own consumption		Gifting		Selling					Urban										Peri-urban											
					Known		Unknown			In/on/at a building				Outside						In/on/at a building				Outside						
Number	Family/self	Group	Known (family/ friends)	Unknown (foodbank)	CSA	Box scheme	Retail	Restaurant	Direct sale (on-farm)	On the roof	On the balcony	Inside	Vertical wall	Garden	Wild' / natural area	Field	Park	Forest	Farm	On the roof	On the balcony	Inside	Vertical wall	Garden	Wild' / natural area	Field	Park	Forest	Farm
1	.	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	x	.	.	.	.	.	.	.	.	.	.	.	.	.
2	x	.	.	.	.	.	.	.	.	.	x	.	.	.	.	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.
3	x	x	.	x	.	.	.	.	x	.	.	.	.	.	.	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.
4	.	.	.	.	x	.	.	x	.	.	.	.	.	.	.	.	.	.	x	.	.	.	.	.	.	.	.	.	.	.
5	x	.	x	.	.	.	.	.	x	.	.	x	.	.	.	.	x	.	.	.	.	.	.	.	.	.	.	.	.	.
6	x	.	x	.	.	.	.	.	.	.	.	.	.	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
7	x	x	x	.	.	.	.	.	x	.	.	.	.	.	.	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.
8	x	.	.	.	.	.	.	x	x	.	.	.	.	.	.	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.

	Ownership							Production method															Maintenance					
	Defined						Un-defined	Indoor									Outdoor			(non) Organic		Renewable resources			Paid		Middle-way		Non-paid	
	Private			Semi-public		Public		Glasshouse			Building			Tunnel															
number	Family/ individual	Company	Group	NGO	Informal group	Public	Squatters	Soil	Water	Artificial	Soil	Water	Artificial	Soil	Water	Artificial	Container	Raised bed	Open soil	Organic/ natural	non-organic/ artificial	Energy	Water	Waste	Company	Individual	Public services	NGO	Group	Individual
1	.	.	.	.	.	x	.	.	.	.	.	.	.	.	.	.	.	.	x	x	.	.	.	x	.	.	.	.	x	.
2	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	x	x	.	.	.	.	.	.	.	.	.	x
3	.	.	.	x	.	.	.	x	.	.	.	.	.	.	.	.	.	.	x	x	x	.	.	x	.	x	.	.	x	.
4	x	.	.	.	.	.	.	.	.	.	.	.	.	x	.	.	.	.	x	x	.	.	.	.	.	x	.	.	.	x
5	.	.	.	.	.	x	.	.	.	.	x	.	.	.	.	.	.	x	x	x	.	.	x	x	.	.	x	.	x	.
6	.	.	.	.	.	x	.	.	.	.	.	.	.	.	.	.	.	x	x	x	.	.	.	.	.	.	.	.	.	x
7	.	.	x	.	.	.	.	x	.	.	.	.	.	.	.	.	.	x	.	x	.	.	.	.	.	.	.	.	x	x
8	x	.	.	.	.	.	.	.	.	.	.	.	.	x	.	.	.	x	x	x	.	.	.	.	.	x	.	.	.	.

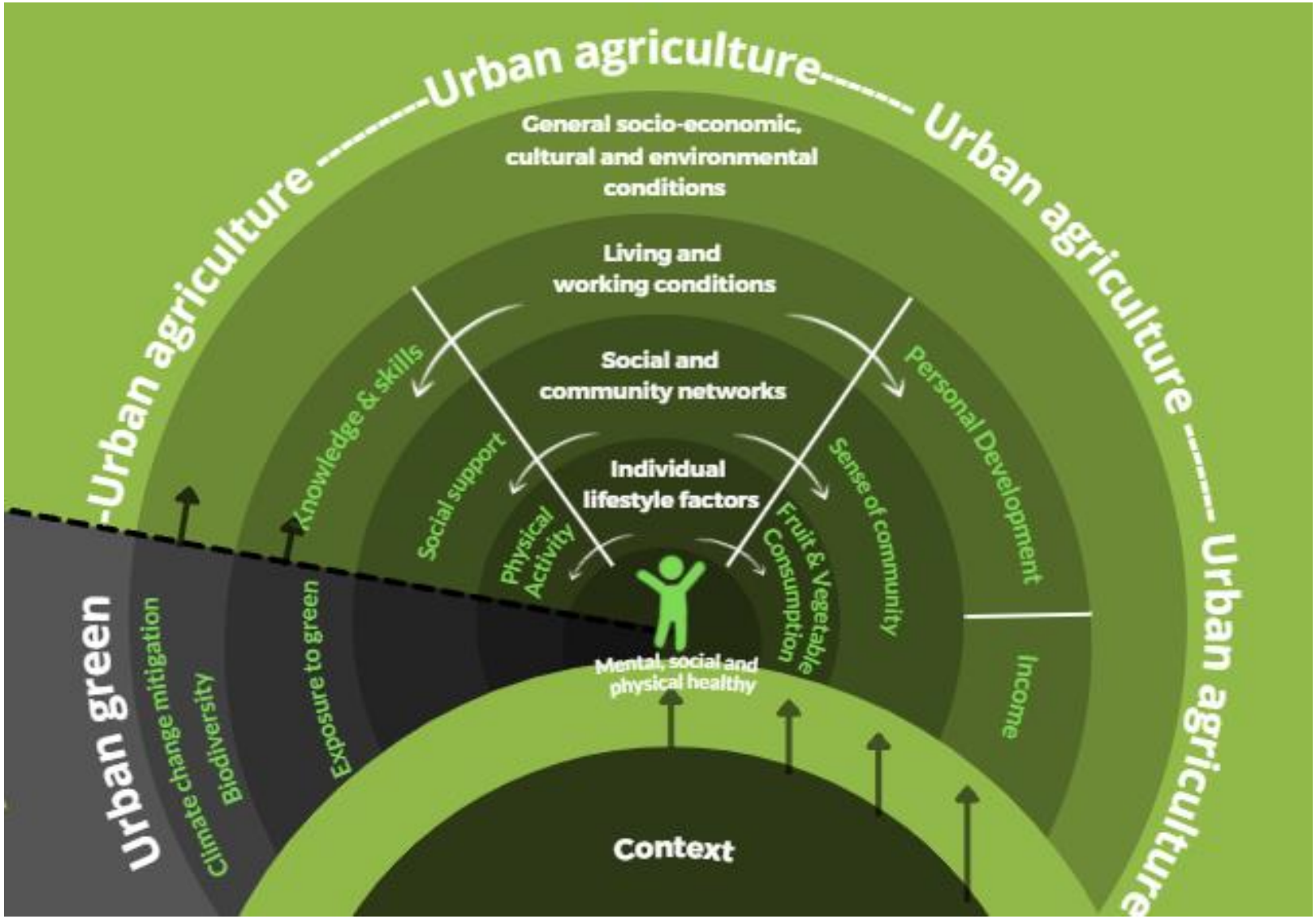
Appendix III: Framework English version



Appendix IV: Framework Dutch version



Appendix V: Redesign of the framework



Appendix VI: Guide semi-structured interviews

Persoonlijke vragen	Wat is je naam	
	Wat is je geboortejaar	
	Kun je meer vertellen over het stadslandbouw project waarin je betrokken bent?	Factoren om op te letten uit de typologie: - Type product - Product bestemming - Locatie - Eigendom - Productiemethode - Onderhoud
	Wat is jouw rol in dit UA-project?	Bezigheden, taken, verantwoordelijkheden
	Hoelang ben je al betrokken bij dit UA-project?	Altijd dezelfde rol gehad, of is dit veranderd?
	Hoe ben je betrokken geraakt bij dit UA-project?	Waarom ben je begonnen? Waarom blijf je betrokken?
	Hoeveel tijd spendeer je in het UA-project?	Per week/maand
Gezondheidseffecten	Ervaar je zelf gezondheids-voordelen van dit UA-project?	Hoe? Kun je dat toelichten?
	Welk effecten van UA merk je zelf op je (mentale, sociale en fysieke) gezondheid	Fysieke verschillen sinds de deelname? Verschillen in je sociale leven of sociale omgeving sinds de deelname? Verschillen in mentale gezondheid sinds de deelname?
		Waardoor denk je dat dit komt (referentie naar vorige antwoorden)
Een A4 kopie van het model laten zien		
Begrijpelijkheid van het model	Begrijp je de boodschap die het model wil overdragen? Welke boodschap denk je dat het model wil geven?	Wat zou de boodschap kunnen zijn?
	Als je naar het model kijkt, welke vragen komen er dan bij je op?	
	Zijn er delen in het model die momenteel onduidelijk voor je zijn?	Welke?
Uitleg van het model		
Herkenbaarheid van het model	Heb je zelf ervaren dat (categorie) is toegenomen of afgenomen door je deelname in dit UA-project.	Of zijn er mensen in je omgeving die dit hebben ervaren door hun deelname in UA

	Heb je zelf een idee hoe (categorie) kan toenemen/afnemen door deelname in UA?	Kun je dat toelichten?
Model met kleuren laten zien	Wat vind je van dit model vergelijking met de vorige.	Waarom?
Waarde van het model	Zou het model voor jou van waarde kunnen zijn?	Nee -> waarom niet, voor wie eventueel wel? Ja -> Hoe zou het model van toegevoegde waarde kunnen zijn? Waarom?
	Voor wie zou het model (ook) van toegevoegde waarde kunnen zijn? (personen, organisaties, instanties)	Hoe kan het van waarde zijn?
Feedback	Denk je dat er nog dingen missen in het huidige model?	Ja -> wat mist er, kun je dat toelichten?
	De uitkomstmaten zijn nu lichamelijke, mentale en sociale gezondheid. Is dat lijst zo compleet? Of mist u nog maten?	Kun je dat toelichten?
	Wat is je mening over het design van het model?	Kun je dat toelichten? Waarom?
	Hoe zou het model verbetert kunnen worden?	Heb je daar een suggestie voor? Hoe zie je dat voor je?
	Welke informatie mis je nog in het model?	Hoe zou je die terug willen zien in het model?
Anders	Zijn er nog andere dingen die je zou willen delen?	
	Heb je nog vragen voor mij?	
	Benoemen dat vragen of toevoegingen altijd nog later doorgegeven mogen worden.	

Appendix VII: Original quotes before translated for report

1. “Het buiten bezig zijn, het aarden, omgaan met, met tegenslag. Het is nooit, het laat zich niet dwingen hè” “Dus, dus, ik denk dat dat sowieso natuur en, en verbouw van groenten dat dat sowieso een meerwaarde is voor ieders gezondheid. Ja, maar daar denkt lang niet Iedereen zo over in onze maatschappij”
2. Klimaat verandering, dat vind ik altijd een lastige […] de beperkte invloed die ik daarop kan hebben. Met dat stukje dat ik in mijn beheer heb, kan ik geen wonderen van verwachten. Dus klimaatverandering is meer iets waar we mee leven en proberen op aan te passen, dan dat we keihard roepen dat wij de oplossing zijn voor.
3. “And you can really taste the difference in a tomato that's grown in the sun versus something that's grown in the greenhouse. It's completely different. So, it's just better, it’s just better. And the type of crops that you can grow as well is completely different. It's what you want versus the limited variety that you can get from a supermarket.”
4. “I think there it's more meditative, if you go and you sit on a bench and you look at like a pretty flower scene in a garden. It's nice, we walk around it, but there you're missing the active aspect of being involved.”
5. “In maart, begin maart zeg maar en toen geleidelijk aan steeds meer. Steeds een dag erbij. Ook om een beetje het fysieke gedeelte op te bouwen. En alleen dus vorige maand dus vier dagen en toen krabbelde ik vrij snel terug, omdat ik dacht: nee dit is echt, dit gaat gewoon niet.”
6. “Ja economisch, nou ja kijk andere dingen spelen ook wel weer een rol binnen dat he. In zekere zin. Want als je vanuit dit groeit, gewoon als persoon. Dan haal je daar vaak ook wel weer dingen uit die je toe kan passen op andere dingen waardoor je misschien ook wel op economisch vlak beter terecht komt.”
7. “Dus in die zin is het heel emancipatief, want wat is er meer emancipatief dan, dan effect kunnen hebben op je eigen gezondheid. Soort van het hoogste goed wat we eigenlijk hebben. Dus een omgeving kunnen creëren waarin je die dingen nog verder ondersteund, dat is voor mij het meest emancipatieve ding wat je een beetje kunt doen ja, ja.”
8. “So, if my friend was on holiday, I would go and water her garden. If I was on, she would water mine. We have a trade off, just to help each other and then also at the same time, we have like cookouts with our harvest, which is super fun. But we try to grow different things in our plots, so we can try each other's food and that's also really, it's a really nice experience.”
9. “Ik denk dat er tussen al die dingen wel een lijn te verzinnen is natuurlijk. Als ik tussen community en physical denk, is het misschien meer een indirecte lijn, dat je wel merkt dat mensen elkaar ook aanzetten om naar dit soort plekken toe te komen en dat je dus en dat daarbij ook wel een soort van, dan spreek ik vanuit de voedseltuin bijvoorbeeld heel erg, dat mensen ook wel zorg dragen voor elkaar en ook doordat ze denk ik in een gemeenschap het gevoel hebben dat ze onderdeel uit maken van de gemeenschap, dat soort daardoor ook beter voor zichzelf gaan zorgen en ook dat mensen elkaar ook er op wijzen om beter voor zichzelf te zorgen. Maar dat is wel een indirecte manier.”
10. “Dat sociale ik denk dat heel belangrijk is voor mensen. Dat vinden mensen echt heel fijn […] dan heb je toch ondertussen een praatje, dat doe je bij de Jumbo niet.”
    “Bijv. X een oude klant, is al dik in de 80 maar die komt twee keer in de week, maar dan ook gewoon dat als ze er niet iets, dat je even belt of dat ik een van de kinderen even langs stuur [om het eten langs te brengen]. Dat hoort er ook eigenlijk allemaal bij.”
11. 17. “Het is een beetje zoals al die mensen waarmee jij praat. Die doen eigenlijk nooit wat in die tuin, maar daar heb je wel veel contact mee. Dat is wel iets wat ontstaat door die tuin weet je wel.”

"Ja, Ik ben daar dan bezig."

"En sommige mensen doen ook wel, dat ze je ineens een bekertje bier geven en zeggen als je die in de grond doet gaan al je slakken erin."

"Ja ik had het er een keer over met één van die vaste voorbijgangers van ik moet eigenlijk bier hebben tegen die slakken en dan komt hij een poosje later aan, hier heb je een blik bier en bekertjes en kijk. En toevallig noemde ik een keer dat er iemand is die haalt er plantjes uit, dus ik miste gewoon plantjes en een afrikaantje bijvoorbeeld, nee twee miste ik. Dus een poosje later, hier afrikaantjes, ik zeg: zeg maar wat je van mij krijgt want ik heb geld in dat potje. Nee hij zegt die groeit op mijn balkon en dat kwam overal op, heb er gewoon wat uitgetrokken. Voor hem is dat sociaal dat hij zich ook weer nuttig voelt en dat geeft ook wel voldoening dat je mekaar dan zo helpt."

12. "Oh dit? Dit is esthetisch onaantrekkelijk. Sorry."
13. "Dat het natuurlijk allemaal met elkaar verband houdt en dan is de vraag wat je in het midden zou zetten. […] ik zou het andersom lezen. Beginnen bij gezondheid en welke factoren moet je rekening mee houden dan en hoe vul je die in. […] het bedrijf staat niet centraal, eigenlijk staat je gezin centraal."
14. "Because I'm also like kind of, I'm really in support of having more of these and a model like this could help to, you know if I were to approach the local municipality about it, to show them these are the impacts that urban agriculture has on, potentially can have on your local community."

Appendix VII: Data management plan

1. Describe the organizational context

Name	Lisa Marijke van den Berg
Date	01-04-2021
Chair group	Rural Sociology Group
Graduate school	Social Science Group
Supervisor/ (co-)promotors	Esther Veen and Lenneke Vaandrager
Start date of project	15 March 2021
File name of this DMP	DMP MSc thesis Lisa Marijke van den Berg

2. Give a short description of your research project

Title	The health benefits of urban agriculture: Exploring the underlying mechanisms
Abstract	*This thesis aims to research the underlying mechanisms for the health benefits of urban agriculture.* The relation between characteristics of urban agriculture and its health-promoting outcomes will be explored, to increase understanding of the underlying mechanisms. Consequently, the research question of this thesis is: "Which mechanisms are underlying to the health benefits of urban agriculture?". Next to that, this thesis aims to increase the integration of urban agriculture in European policy and practice. By the development of a framework, the mechanisms that lead to health-promoting features of urban agriculture will be graphically presented to stakeholders. The framework should be comprehensible for stakeholders to guide future decision-making processes with regard to urban agriculture. To verify this, interviews will be conducted with the stakeholders.

3. Define data management roles

Roles	
Who is collecting the data?	Lisa Marijke van den Berg
Who is analysing the data?	Lisa Marijke van den Berg
Other	X
What is the role of your **supervisor?**	My supervisors will supervise my research methods and process.

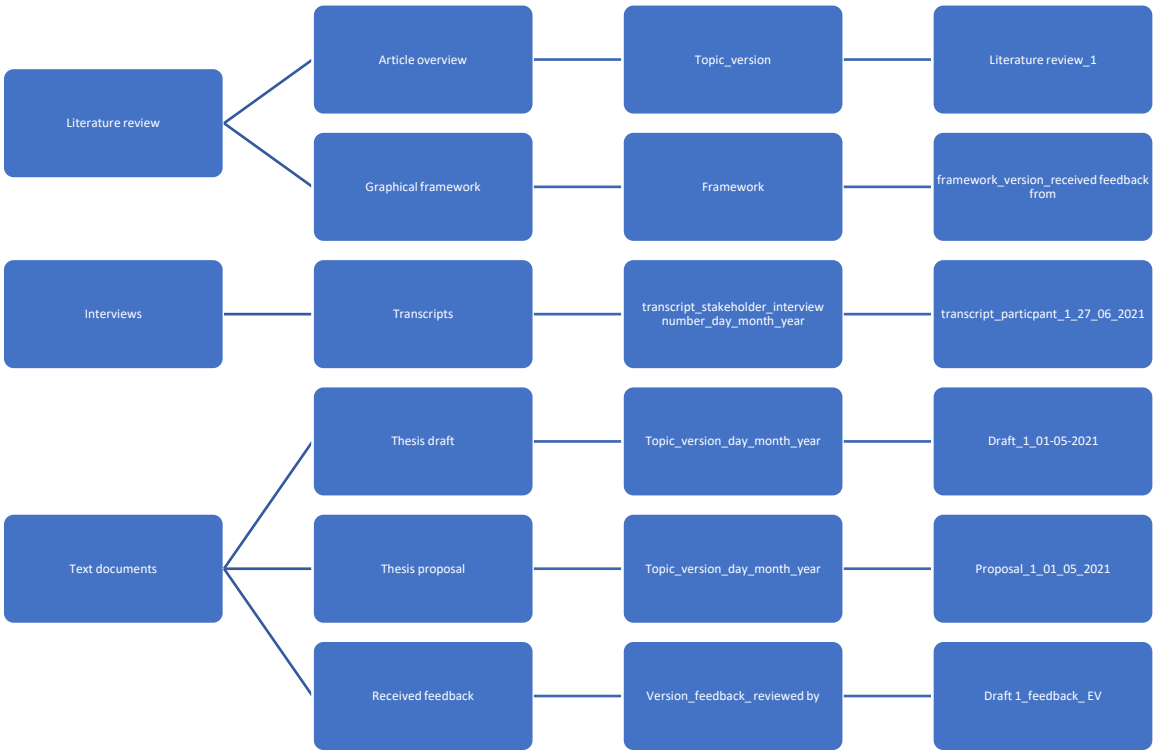
4. Give an overview of expected types of research data, software choices, and data size & growth

Data stage	Specification of type of research data	Software choice	Data size/ growth
Raw data	Interview notes	Word (.docx)	kB
Processed data	Literature review overview	Excel (.csv)	MB
	Quality appraisal literature review	Excel (.csv)	MB
	Interview transcripts	Word (.docx)	MB
Models/code	X		
Other?	X		

5. Short-term storage solutions*

Data stage	Storage location	**Backup procedures** (storage medium and location/ how often?)
Raw data	External storage device (USB flash drive) with regular updates in cloud service	Data will be stored on a USB flash drive. To minimize risk of damage or losing, the data will be regularly back-up at the cloud service of WUR: Sharepoint. Back-up intervals will depend on the changes in the data. Data will be backed-up on a daily basis after changes.
Processed data	External storage device (USB flash drive) with regular updates in cloud service	Data will be stored on a USB flash drive. To minimize risk of damage or losing, the data will be regularly back-up at the cloud service of WUR: Sharepoint. Back-up intervals will depend on the changes in the data. Data will be backed-up on a daily basis after changes.
Models/code	X	
Other?	X	

6. Structuring your data and information



7. Documentation and metadata

The dataset contains peer reviewed scientific articles that will be appraised on their quality with the MATT framework in an excel file. From each article, the characteristics will be determined (if possible) according to the EFUA typology for urban agriculture. The articles will be derived from SCOPUS, in May/June 2021 and analysed by the thesis student. After that, a framework will be developed to reflect the findings of the literature review. This framework will be evaluated by stakeholders via interviews. These interviews will be conducted in an urban agriculture project amongst stakeholders. The interviews will be conducted by the thesis student with semi structured format. The interviews will be transcribed. The feedback from the interviews will be used to improve/adjust the framework, to make it a useful tool for urban agriculture development in the future.

8. Sharing, ownership and privacy

Sharing, ownership and privacy	(With) who(m), what and how?
Data sharing - Do you expect that others may be interested in re-using your data? Do you have plans to share your data with these parties? - How are you going to make sure your datafiles will be accessible once you leave the department? Who will take care of your data?	The thesis is part of the European Forum on Urban Agriculture project, which might be interested in the outcomes of this thesis. If needed, I can share my data of the literature search (excel files) and the interview transcripts (word files) with the EFUA on request.
Data ownership - Any funders requirements to share your data, or to impose an embargo? - Are there agreements on how the data will be used and shared within your group or with other parties involved in this research? (outside your group or outside Wageningen University & Research)	Not applicable
Privacy - Are there privacy or security issues, and if there are, how are you dealing with them?	It is important that the interviews will be conducted anonymously, this will be done through numbering the participants. Names will not be mentioned in the transcripts, only their role and characteristics (e.g., age, gender, involvement in type of urban agriculture). However, it should be noted that most probably, no sensitive information will be discussed in the interviews.