Identifying mechanisms that shape the food environment in long-term healthcare facilities in the Netherlands: a participatory system dynamics approach

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Abstract

Background Creating healthy and sustainable food environments within long-term healthcare facilities asks for a systemic approach. This study aimed to: (1) identify system dynamics underlying the food environment of long-term healthcare facilities, (2) formulate actions for changing the system to promote a healthy and sustainable food environment and (3) evaluate stakeholder perspectives about the process and progress towards action implementation up to one-year follow-up.

Methods A group model building (GMB) approach was used during two workshops with stakeholders of five different long-term healthcare facilities in the Netherlands. Stakeholders created a causal loop diagram (CLD) and formulated actions for change. Interviews were conducted at six- and twelve months to evaluate perspectives on the GMB process and progress towards action implementation.

Results The developed CLD consisted of 30 factors influencing the food environment in long-term healthcare facilities and four interrelated subsystems (patient; healthcare organization; national governance and policy; purchasing, procurement and budget). Stakeholders formulated 40 corresponding actions. After one year follow-up, small steps towards action implementation were observed (e.g., agenda setting, raising internal awareness, formulating plans), with several barriers hindering implementation being noted (e.g., lack of time, budget, priority).

Conclusions This study gained a comprehensive, collectively acknowledged understanding of the system dynamics underlying the food environment in Dutch long-term healthcare institutions. The results underscore the importance of crafting a coherent set of actions that addresses various factors and underlying mechanisms to initiate systemic change. However, achieving actual system changes in long-term healthcare facilities requires prolonged efforts and overcoming barriers towards implementation.

Keywords Food environment, Healthcare institution, Long-term care, System dynamics, Group model building, Causal loop diagram

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Background

Long-term healthcare facilities are institutional healthcare settings where people reside to receive care and support for an extended period. Given that often vulnerable people reside in this setting, optimizing nutrition plays a pivotal role in promoting health, including the prevention of malnutrition and diseases and appropriate healing and recovery from illness [1, 2]. As such, these healthcare settings can play an exemplary role in stimulating healthy and sustainable food choices. Food choices are largely influenced by the food environment [3–5]. The food environment can be defined as the "collective physical, economic, policy, and sociocultural surroundings, opportunities, and conditions that influence people's food and beverage choices and nutritional status" [6]. Current healthcare food environments are not supportive of healthy food choices [7]. To contribute to the optimization of nutrition in long-term care facilities, from now on indicated as *healthcare institutions*, it is essential to create supportive food environments that contribute to the optimization of nutrition.

Prior research showed that patients in healthcare institutions often eat together in household settings, where it is important that food is tasty and appealing [7]. Food is often used as an instrument and is not only serving a nutritional role, but also a cultural role and is tied to social relationships. To illustrate, a study in Dutch nursing homes found that staff did not want to patronize patients and used food as a way to pamper patients, e.g. by offering unhealthy extra snacks [8]. The importance of a healthy food environment in healthcare settings is evident, however, translating this into effective practice remains a challenge and asks for a systemic approach. At this time, little is known about strategies and interventions to improve food environments in healthcare institutions. Prior research predominantly focused on isolated aspects of the healthcare food environment, for example by evaluating the effect of improving the food assortment of healthcare restaurants, shops or vending machines [9–11]. While these interventions show positive, but small effects of improving such aspects of the food environment, there remains a limited understanding of strategies that could improve the broader food environment in the entire healthcare institution. To create interventions with enduring structural and broad-reaching effects, it is vital to gain a comprehensive understanding of the food environment within healthcare institutions, encompassing interactions among factors, feedback loops, and underlying mechanisms.

Elements of systems thinking [12–15], could be a valuable strategy for gaining a comprehensive understanding on how to improve the food environment in healthcare institutions. In fact, the food environment in healthcare institutions can be described as a complex adaptive system with a variety of contexts, stakeholders, and interests and multiple dynamic relationships between them. It consists of a web of interconnected factors and subsystems that affect what is offered and consumed, and where these components also influence each other in a non-linear way and adapt unpredictably over time [16]. Systems thinking gives insights (and acknowledges and addresses) into this complexity and allows to identify places in the system that can be shifted to transform the system [17]. These places can consist of points of intervention that may not be immediately visible when discussing the healthy food environment.

Several methods exist to employ systems thinking [18, 19]. Group model building (GMB) [20] is one of them and is a widely used participatory approach, facilitating collective understanding of complex systems and its dynamics while engaging stakeholders and integrating stakeholders' perspectives. The GMB process discloses the causal structures of a complex system, increases the development of systems solutions and identifies leverage points and actions for change. GMB is a method that has recently been used in public health research but only few evaluations have been conducted until the action implementation stage, and almost none were long-term evaluations [21]. Several studies used GMB to engage participants in systems thinking for improvement of the food environment in different contexts, for example for increasing fruit and vegetable intake in children [22], for recognizing the system driving unhealthy eating [23], or to improve an urban neighbourhood food system [24]. To the best of our knowledge, there are no studies that used a GMB approach to improve the food environment in healthcare institutions.

The aims of this study were threefold. First, we aim to identify the system dynamics underlying the food environment of healthcare institutions and to formulate systems actions to create a healthy and sustainable food environment. Second, we aim to evaluate stakeholder perspectives about the systems process and third, we aim to evaluate the progress towards implementing the actions up to one-year follow-up. The outcomes of this study will give an understanding of the complex system that shapes the food environment in Dutch healthcare institutions and actions that could lead to a system that promotes healthy and sustainable food choices in healthcare institutions.

Methods

Context

The study was part of 'the Regio Deal Foodvalley', a long-term collaboration between the Dutch national government and parties from the region aimed at accelerating the transition towards a healthy and sustainable food system. These parties included different regional

governments, entrepreneurs, education- and knowledge institutions, including the Nutrition & Healthcare Alliance, a national expertise centre that aims to realize health benefits by applying scientific findings on nutrition and exercise in prevention and healthcare [25]. The participating healthcare institutions were situated in the Foodvalley region and were also embedded in the network and knowledge of the Nutrition & Healthcare Alliance to help them implement the actions to improve their food environment.

Design
This qualitative study used a group model building (GMB) approach. GMB is a qualitative participatory method and a form of action research [20], that engages a group of stakeholders to think in systems and to create a shared understanding of complex issues, a shared involvement of participants and to develop different actions for system change. In this study, GMB was used to gain insight into factors, their connections and underlying mechanisms that shape the food environment of healthcare institutions, and to identify actions at different system levels that could lead to a system that promotes a healthy and sustainable food environment for patients, visitors and staff. In this study, the term patients will henceforth refer to patients, as well as clients and other health care receivers. The practical contribution of the GMB to the workshop structure lies in its ability to enhance engagement and collaborative understanding of complex systems among participants. This was done by the use of standardized GMB scripts that structured the workshop in a particular order and provided concrete activities.These activities are detailed in the scripts in Additional file 1 [27].

Healthcare institutions engaged in a one-year study trajectory in the Netherlands which included: two GMB sessions in Wageningen, in May and June 2022 and a questionnaire after both sessions to evaluate the perspectives on the GMB process, two contact moments to stimulate implementation of action (an action implementation meeting (Sep-Dec 2022) and a webinar (Feb 2023) and a closing session in Ede, in May 2023 (see Fig. 1). Two semi-structured follow-up interviews per healthcare

institution at six (T1) and twelve months (T2) evaluated the perspectives of the stakeholders on the GMB process and progress towards implementation of actions. A co-creative inquiry using a large qualitative time-line during the closing session at the end of the one-year trajectory identified the implementation progress and additional needs for future improvements to realize a transition of the food environment in healthcare institutions [26, 28]. Ethical approval (ethical approval number: 2021-38-Wierda) was obtained from the Social Sciences Ethics Committee of Wageningen University & Research.

Recruitment and participant characteristics
With support of the Nutrition & Healthcare Alliance in the Netherlands, the first author (JJW) approached nine healthcare institutions, of which five agreed to participate in the one-year study trajectory, including a rehabilitation centre, two nursing homes, a mental healthcare institution and an institution for people with intellectual disabilities. Healthcare institutions were approached via e-mail and telephone and asked for a main contact person, preferably in a management function, who was professionally engaged with the food environment of their healthcare institution. Then, an introduction meeting between the first author and the main contact person was scheduled to explain the terms of the study and to officially invite them to participate. To recruit a variety of participants for the GMB sessions, we asked the main contact person to engage and invite a minimum of two and maximum of five stakeholders (i.e. nurses, facility managers, dietitians) representing their healthcare institution and who were professionally engaged with the food environment. Healthcare institutions could request a financial compensation (fifty euros per hour per participant) for participation during the sessions. For the interviews at six and twelve months, only the main contact persons were invited. Because of time constraints only the main contact persons were invited, as interviewing everyone was not feasible. We also expected that the main contact persons would also represent the other study participants, and would have a good overview of the organizational changes. Characteristics of the participants for each part of the study can be found in Table 1.
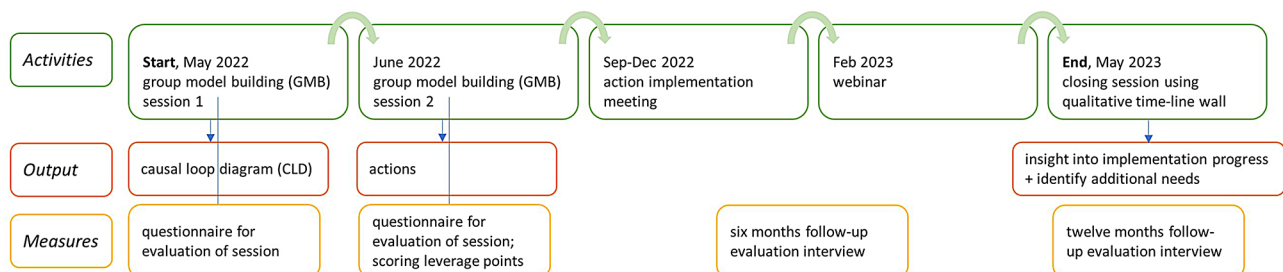

Fig. 1 One-year study trajectory: activities for participating healthcare institutions, outputs and measures

Table 1 Participant characteristics and attendance during sessions and interviews

P#	Representative of healthcare institution type	Function	Male (M) or female (F)	Attended GMB[a] session 1 Total n = 10	Attended GMB[a] session 2 Total n = 9	Six months interview (T1) Total n = 5	Twelve months interview (T2) Total n = 5	Attended closing session Total n = 9
P1	Nursing home A	Dietitian	F	V	V	V	V	V
P2	Nursing home A	Dietitian *(changed job after session 2)*	F		V			
P3	Nursing home A	Location manager rehabilitation	F					V
P4	Nursing home A	Care staff						V
P5	Nursing home A	Project employee quality, policy and innovation	F					V
P6	Rehabilitation centre A	Team leader services	M	V	V	V	V	V
P7	Rehabilitation centre A	Nurse	F	V				
P8	Rehabilitation centre A	Manager services	M					V
P9	Rehabilitation centre A	Facilities manager	F					V
P10	Intellectual disabilities A	Location manager	F	V	V		V	
P11	Intellectual disabilities A	Health scientist & dietitian	F	V		V		
P12	Intellectual disabilities A	Dietitian	F		V			
P13	Intellectual disabilities A	Policy officer	F					V
P14	Nursing home B	Dietitian	F	V	V	V	V	
P15	Nursing home B	Dietitian	F	V	V			
P16	Nursing home B	Facilities specialist	M					V
P17	Mental health care A	Nutrition coordinator	F	V	V			
P18	Mental health care A	Nutrition coordinator	M	V	V			
P19	Mental health care A	Manager facilities	M	V[b]		V	V	

[a] GMB = group model building

[b] Attended only the first hour

All participants agreed to participate by signing an informed consent form.

Study activities

GMB session 1

The aim of the first GMB session (3,5 h) was to create a causal loop diagram (CLD), to identify and illustrate the system that promotes a healthy and sustainable food environment in healthcare institutions by identifying factors, connections and mechanisms that influence the system. Factors that were direct components of the food environment (e.g. food availability) were excluded from the CLD. The research team guided participants through different activities during the sessions, that were derived from evidence-based system dynamics scripts from Scriptapedia [27]. An explanation of the full program of session 1 can be found in Additional file 1. During the first session, the research team fulfilled the following tasks: facilitators (MPP and SCD), physical wall builder (MPP), digital wall builder (TMW), several note takers (JJW and research assistants) and a time keeper (JJW). The STICKE software (Version 3, Deakin University) was used to visualize and project the factors and associations into a CLD.

GMB session 2

GMB session 2 took place one week after GMB session 1. In preparation of the second GMB session, the research team identified twelve leverage points that emerged from the loops in the CLD. The first aims of session 2 (3,5 h) were to perform a member check to verify the CLD, identify and prioritize leverage points on perceived changeability and impact. Two new leverage points were identified during the member check with participants. Eventually, some leverage points were merged, resulting in twelve leverage points. The second aim of this session was to identify actions for optimizing the food environment in healthcare institutions at different levels of the system, using several individual and plenary activities, that were again derived from evidence based system dynamics scripts from Scriptapedia [27]. During the second session the research team fulfilled the following tasks: facilitators (MPP and SCD), wall builder (MPP), note takers (JJW and research assistants) and timekeeper (JJW). A summary of the program of session 2 can be found in Additional file 1.

Action implementation meeting and webinar

During the one-year follow-up there were two contact moments to support the implementation of actions within the healthcare institutions. The first moment

was between September and December 2022, where each healthcare institution was visited (approximately 60 min) by the first author (JJW) and a representative of the Nutrition & Healthcare Alliance. The aim was to discuss the successes and bottlenecks they experienced in the past months with respect to the implementation of actions and additional efforts to improve the food environment. Additionally, each healthcare institution was provided with tools and help of the Nutrition & Healthcare Alliance to overcome potential bottlenecks. During the second contact moment (February 2023), representatives of four of the five healthcare institutions attended a generic national network webinar (75 min with $n = 23$ healthcare institutions) organised by the Nutrition & Healthcare Alliance aimed at inspiration, sharing experiences and asking questions about the realisation of a healthy food environment. Also, a representative of a hospital that had already made substantial improvements to the food environment shared their insights and business case.

Closing session

A closing session (T2) was organized by the researchers in collaboration with the Nutrition & Healthcare Alliance to gain insight into the implementation progress made during the one-year follow-up period and to identify additional needs required for further realization of a healthy and sustainable food environment. During this session the 'time-line wall' method was used (Fig. 2) which aimed to evaluate a process and visualize activities in time [26, 28]. For the construction of the time-line wall two central questions were asked to participants. First, what has been realized over a one-year period, i.e. which steps have been taken towards the improvement of the food environment in your healthcare institution? Second, what is needed to realize a healthy and sustainable food environment in your healthcare institution by 2030? For the second question participants had to formulate three important breakthroughs to come to a healthy and sustainable food environment by 2030. Participants first reflected individually upon the questions, before discussing their thoughts with their colleagues. Participants wrote their input on post-its and placed them on a wall where a time-line was visualized (please see Fig. 2 for an impression). Findings were shared in a plenary discussion with participants standing in front of the time-line wall.

Study procedure and measures
Evaluation of the GMB sessions

At the end of both GMB sessions, a questionnaire was used to measure participant involvement (i.e. '*I felt involved in making the CLD' (session 1) and 'I felt involved in identifying actions' (session 2))*, the degree of systems thinking (i.e. '*The session gave me insight into factors and connections influencing the food environment' (session 1)* and the degree of action awareness (i.e. '*The session gave*

Fig. 2 Time-line wall input during the closing session

me insight into actions that could influence the food environment' (session 2)), that could be answered on a 5-point Likert scale, ranging from 1, fully disagree to 5, fully agree. Two open-ended questions were included about which harvest of the session the participants would share within their institution and what would be required to implement the identified actions. The questionnaire was based on a survey used in another study that evaluated system mapping [29].

Evaluation of the leverage points
In GMB session 2, participants were asked to individually score each leverage point on changeability (i.e., how easy or difficult is it to change this within their healthcare institution) and impact (i.e., the impact on improving the food environment) on a scale from 0 to 10, with 0 being least changeable or impactful and 10 being most changeable and impactful.

Evaluation of the system levels of the actions
To facilitate the identification of actions that can reorientate the system, the Action Scales Model (ASM) tool of Nobles [16] was used. The tool describes four levels (events, structures, goals and beliefs) with deeper levels yielding increased potential for changing the system. The actions were appraised by the research team according to the four levels of the ASM tool to evaluate the potential leverage impact on the system.

Evaluation of GMB process and progress towards action implementation
Six (T1) and twelve (T2) months after the GMB sessions, online semi-structured interviews (via Microsoft Teams) were conducted with the key contacts representing the five participating healthcare institutions. Topics central to the interview were looking back on the study trajectory, facilitators and barriers and goals and ambitions for transitioning towards a healthy and sustainable food environment. The interview guide was created for this study, topic details, prompts and the full interview guide (translated from Dutch to English) can be found in Additional file 2. The interviews were conducted in Dutch by one author (JJW), audio-recorded, and lasted between 29 and 42 min. The outcomes of the closing session (i.e., what has been realized and what is needed for improving the food environment) were included in the progress evaluation towards action implementation.

Data analyses
Creating the CLD was an iterative process. After the first GMB session the research team made a concept CLD, which was validated during the second GMB session using member checking. After this member check, the CLD was finalized by the research team. The CLD results

were illustrated with quotes, derived from the notes taken during the sessions. These quotes were not necessarily fully literal, because the note takers in both sessions were unable to transcribe literally and to record who said what due to the speed of the conversations. The factors and mechanisms of the CLD were visualized via STICKE software (Version 3, Deakin University). Based on the visualization via STICKE the research team replicated the CLD and identified feedback loops using Vensim PLE 8.1.0, software to visualize feedback loops. Feedback loops are relationships between factors, where one factor leads to a change (growth, decline or stabilisation) in another factor that again leads to a change in the original factor. A positive feedback loop generates a reinforcing change and can lead to growth or decline (i.e. reinforcing feedback) and a negative feedback loop generates a balancing change and can have a stabilising effect (i.e. balancing feedback). The layout of the system map figures was created by an illustrator.

Changeability and impact of the leverage points and the questionnaires for stakeholder evaluation of the GMB sessions were analysed using descriptive statistics in Microsoft Excel. The follow-up interviews at six and twelve months were anonymized and thematically summarized by the first author. The input on the time-line wall was collected from the closing session, and main themes were identified using thematic content analysis from the post-its on the wall and notes of the session. The results of the interviews and time-line wall were illustrated with quotes translated from Dutch to English.

Results
Causal loop diagram
The CLD as presented in Fig. 3 shows the system that shapes a healthy and sustainable food environment in healthcare institutions, formed by 30 factors, connections and mechanisms that influence the system. The arrows symbolize the connections between factors. An arrow with a plus symbol indicates that the relationship between the factors is positive (if the variable increases or decreases, the connected variable also increases or decreases correspondingly). An arrow with a minus symbol indicates that the relationship between the factors is negative (if the variables increases, the connected variable decreases, or if the variable decreases, the connected variable increases). Each colour represents a subsystem, in which factors are clustered. The following four connected subsystems were identified: (1) the healthcare organization, (2) the patient, (3) purchasing, procurement and budget and (4) national governance and policy. A total of six reinforcing feedback loops were identified, indicated by 'R' in the diagram. The identified leverage points are numbered and underlined.
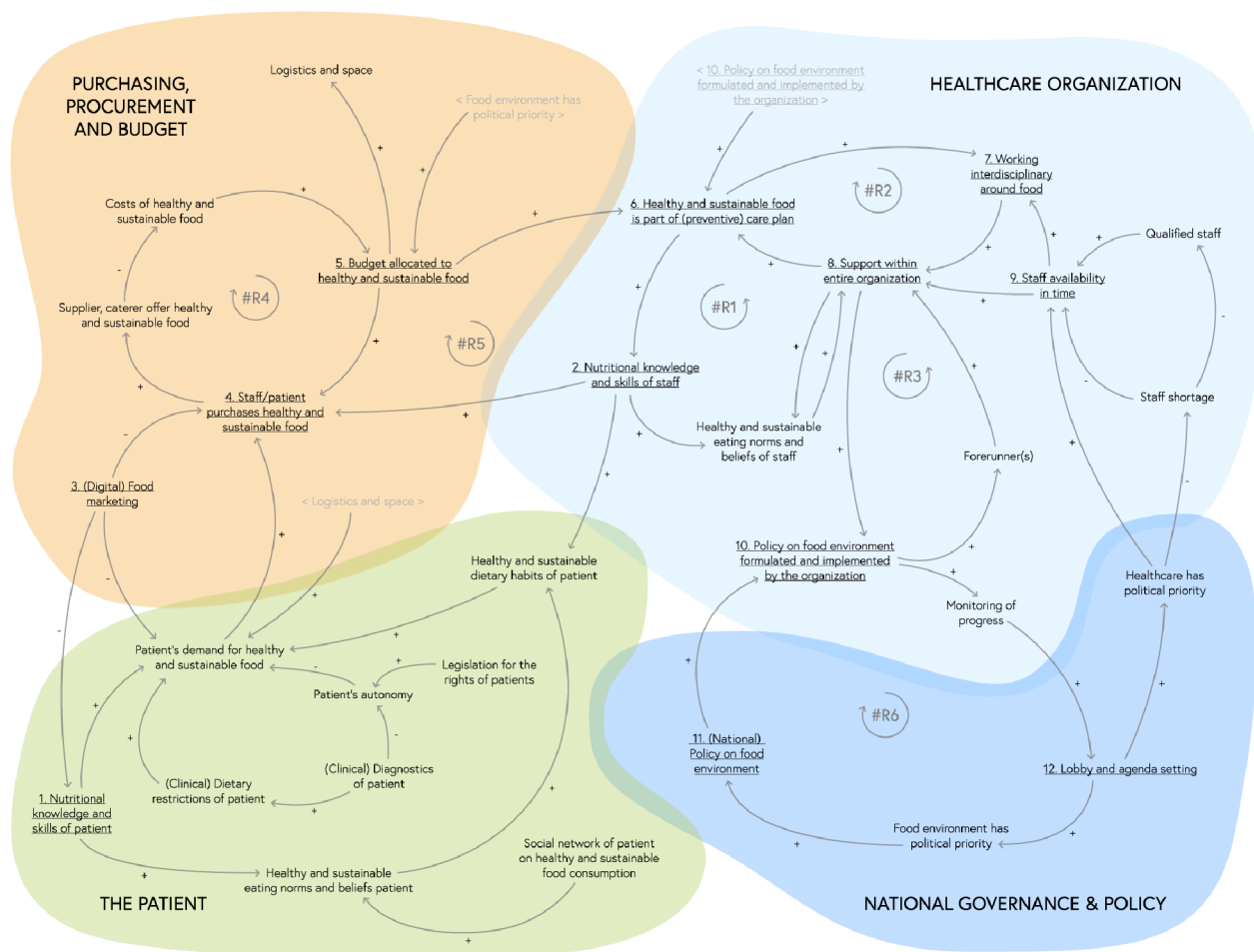
Fig. 3 Causal loop diagram shows the system that shapes the food environment in healthcare institutions. Each colour represents a subsystem; feedback loops are indicated by an 'R' followed by a number; leverage points are underlined

Subsystem healthcare organization

Factors related to the healthcare organization are displayed in the light blue subsystem in Fig. 4. Most of the identified factors centre around support for a healthy and sustainable food environment within the *entire* organization. As illustrated by a participant: "*I think support within the organization is very important, that is where it starts*". Another participant noted: "*what really strikes me, is that the complexity [of the map] is within the healthcare organization part*". Three reinforcing feedback loops were identified within this subsystem. Feedback loop 1 indicates that broad support for healthy and sustainable food environments in the entire organization leads to the integration of healthy and sustainable foods in (preventive) care plans. This, in turn, increases nutritional knowledge and skills of staff, that positively shapes their norms and beliefs regarding healthy and sustainable eating, which fosters further support within the healthcare organization (R1, Fig. 4). Feedback loop 2 shows that if healthy and sustainable food is part of a (preventive)

care plan for patients, this will enhance interdisciplinary working around food within the organization. Interdisciplinarity can also broaden the support for the creation of a healthy and sustainable food environment within the entire healthcare organization and that will increase the likelihood that healthy and sustainable food will become part of a (preventive) care plan for patients (R2, Fig. 4). Feedback loop 3 shows that having a 'forerunner' who initiates or leads change in the transition towards a healthy and sustainable food environment, is beneficial for creating support towards a healthy and sustainable food environment in the entire organization. For example, a person on management or board level who disseminates the importance of healthy and sustainable food and the role of the food environment can increase support, which can accelerate the implementation of food environment policies. An implemented food environment policy is again helpful in attracting and guiding forerunners, the beginning of feedback loop 3 (R3, Fig. 4).
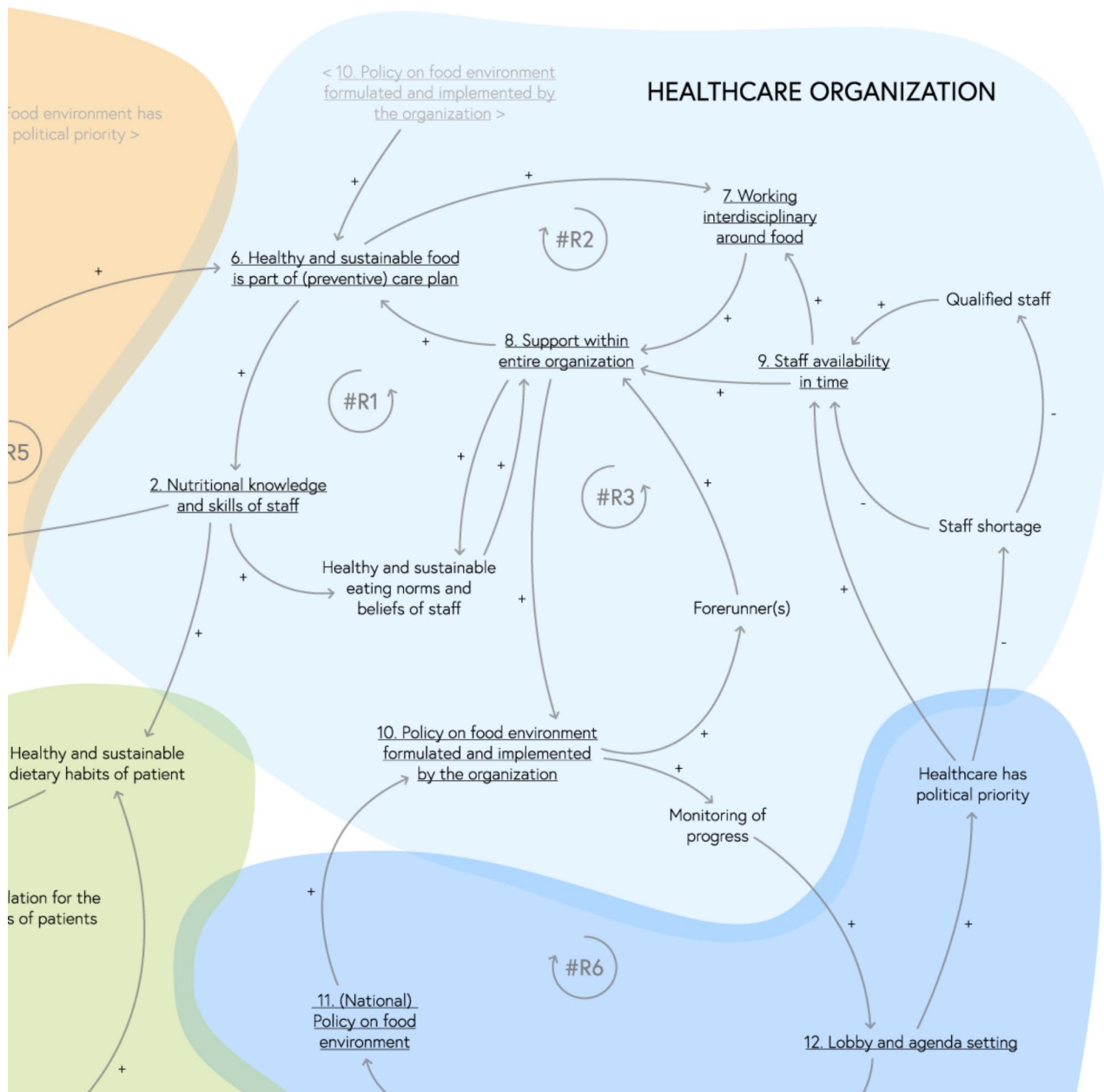
Fig. 4 Causal loop diagram subsystem healthcare organization

Subsystem the patient

Factors related to the role of the patient are displayed in the green subsystem (Fig. 5). No feedback loops were identified here. Most factors in this subsystem had a direct influence on the patient's demand for healthy and sustainable food, including nutritional knowledge and skills, (clinical) dietary restrictions, patient's autonomy, healthy and sustainable dietary habits and a more distal factor, namely the influence of (digital) food marketing. The patients' demand for healthy and sustainable foods influenced the food purchases of staff and patients, e.g. patients asking staff to prepare or buy healthy and sustainable foods. Indirect factors that influenced patients' demand for healthy and sustainable foods were the social network of patients, which in turn influenced the eating norms and beliefs of patients. The (clinical) diagnostics of patients and related (clinical) dietary restrictions affect the patients' demand for food within the healthcare institution. Participants discussed the influence of patients' autonomy and the influence of associated regulations on the demand for healthy and sustainable food. The autonomy and rights of individuals with intellectual disabilities or psychogeriatric conditions receiving involuntary care are protected and regulated in
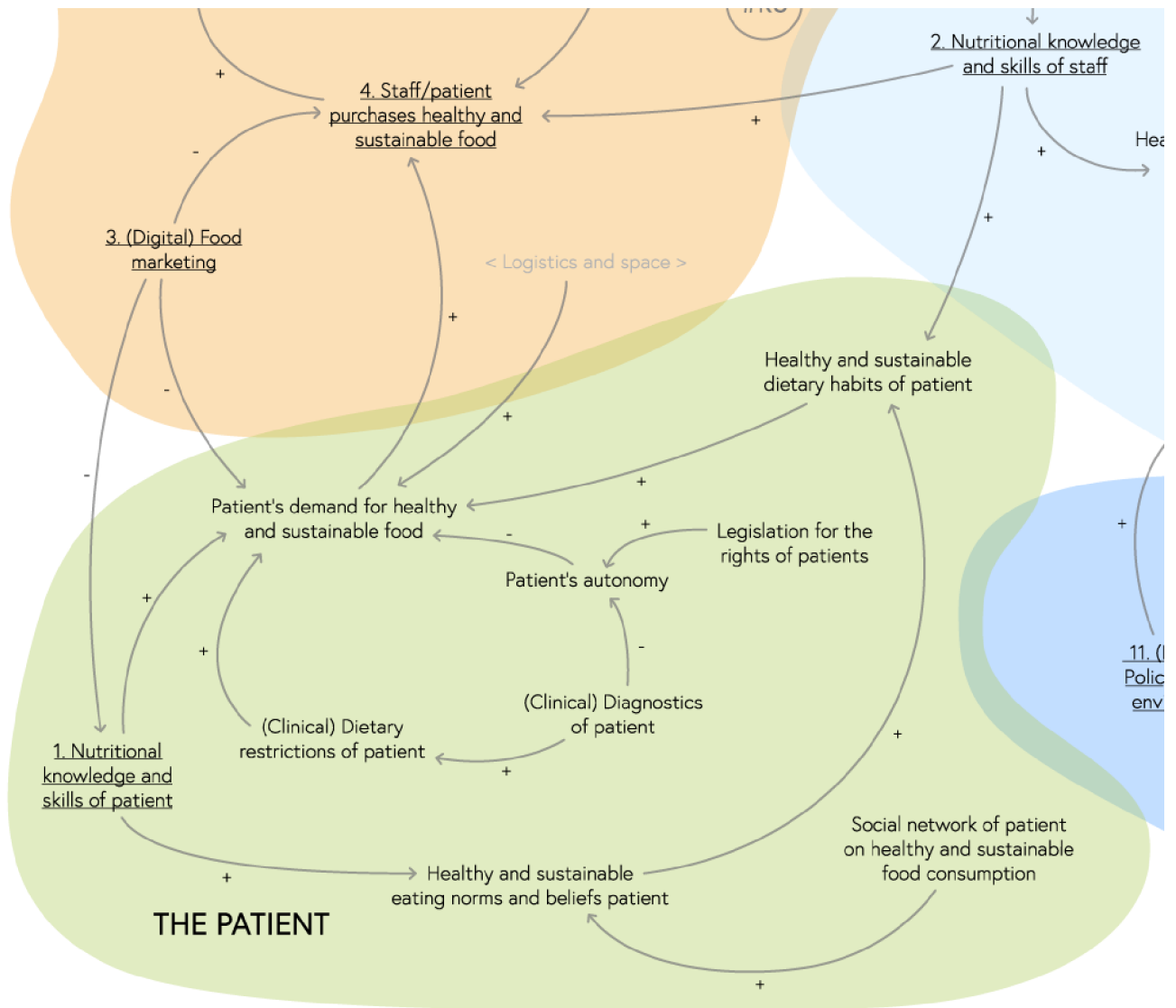
Fig. 5 Causal loop diagram subsystem the patient

the Netherlands by the Care and Coercion Act (in Dutch: Wet Zorg en Dwang or Wzd 2020) [30], to ensure these individuals receive adequate care. Since diet and prevention are not part of this Act, it was indicated that patients often have full autonomy over their food choices, and the right to choose an unhealthy diet, illustrated by a participant: "*it is not allowed that a health care receiver crosses the road [e.g. a busy roadway], but that someone [figural] eats him or herself to death is allowed, as this does not happen overnight*".

Subsystem purchasing, procurement and budget
Factors related to food purchasing, procurement and budget available for healthy and sustainable food are displayed in the orange subsystem (Fig. 6). In many healthcare institutions, staff members are tasked with

procuring the food that patients consume, yet in some healthcare institutions (e.g. mental healthcare, institutions for people with intellectual disabilities) patients take on the responsibility of obtaining their own meals. Reinforcing feedback loop 4 shows that an allocated food budget would increase the purchases of healthy and sustainable food by staff and patients, which will enhance the (external) suppliers' and caterers' offerings of healthy and sustainable foods (supply and demand), which, in turn, will lower the costs of healthy and sustainable foods. As a result, more budget can be allocated to healthy and sustainable foods which in turn leads to an increase of healthy and sustainable food purchases by staff and patients (reinforcing loop R4, Fig. 6). A participant elaborated on this: "*in theory there is budget, but in practice it is often not clear for what that budget is, for*
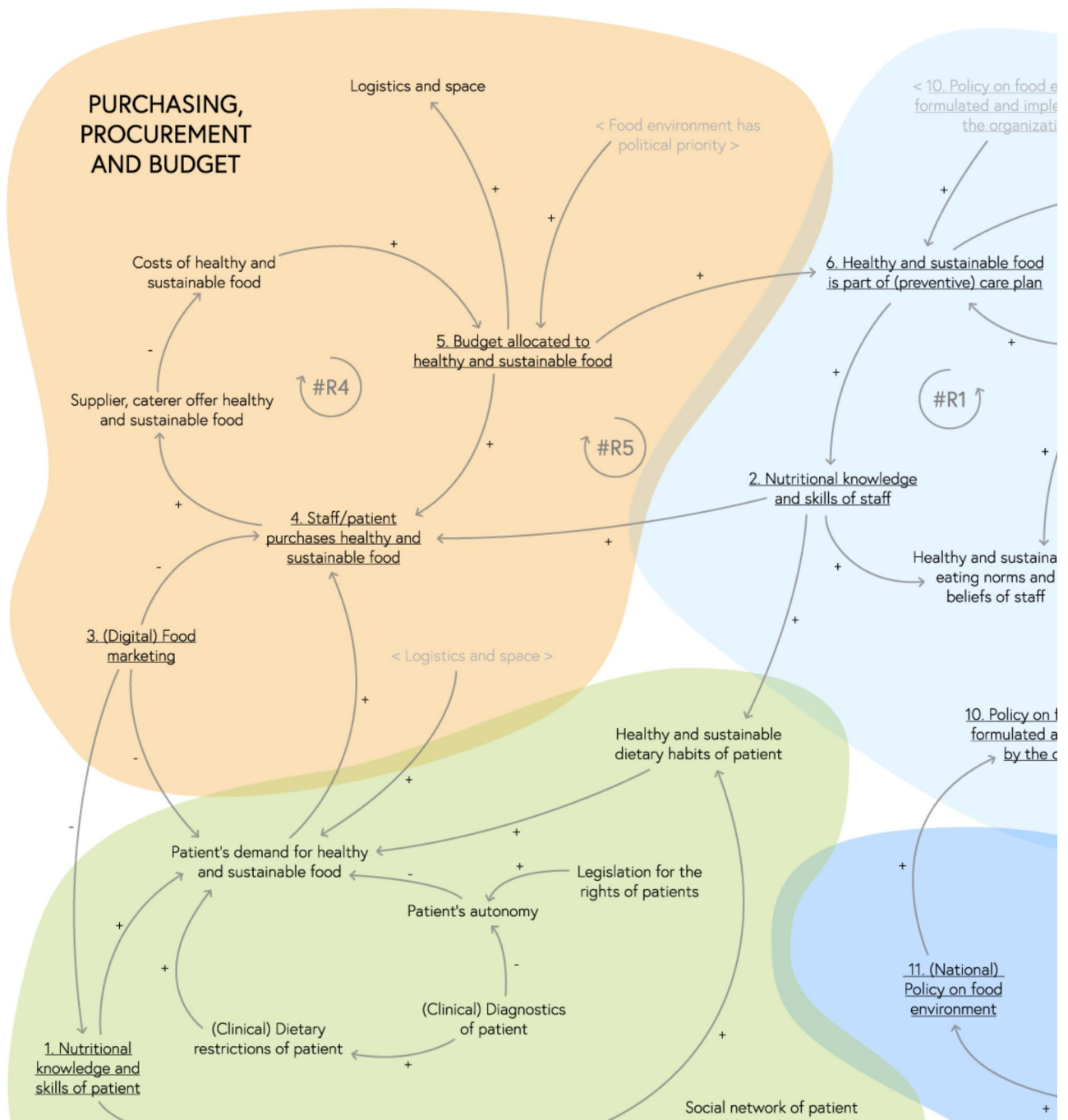
Fig. 6 Causal loop diagram subsystem purchasing, procurement and budget

example, it is also for household products and then there is no budget left anymore for foods" and another participant said *"there is no budget for healthy food, because it is more expensive than unhealthy food".* Feedback loop 4 can be extended to feedback loop 5, adding that more budget allocated to healthy and sustainable foods can increase the likelihood that healthy and sustainable food is part of a (preventive) care plan, which in turn can enhance the nutritional knowledge and skills of staff (subsystem the

healthcare organization) and with that increases the purchases of healthy and sustainable foods by staff/patients (reinforcing loop R5, Fig. 6).

Subsystem national governance and policy

The final subsystem, displayed in dark blue, illustrated how factors related to national governance and policy shape the healthcare institutions' food environment (Fig. 7). Reinforcing feedback loop 6 shows that lobby
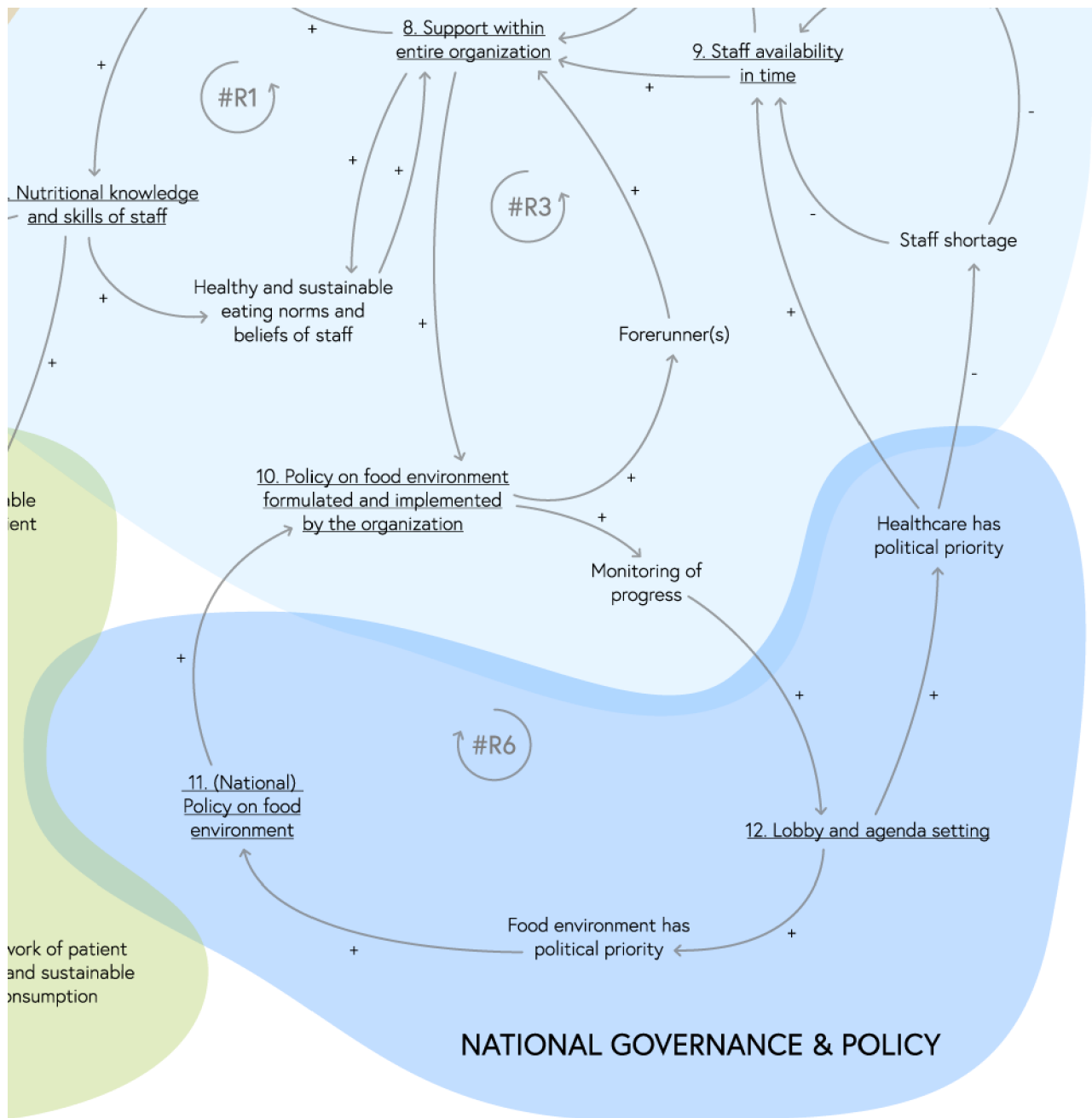
Fig. 7 Causal loop diagram subsystem national governance and policy

and agenda setting by e.g. civil society organizations can contribute to higher political priority and more (national) policy to create healthy and sustainable food environments, which in turn can enforce healthcare institutions to formulate and implement policies. Having a food environment policy within healthcare institutions can impose monitoring or evaluation of the food environment and this can help to empower the role of lobby and agenda setting, the start of feedback loop 6 (R6, Fig. 7). Illustrated by a participant: *"Lobbying is important and trade*

associations have large influence, not only trade associations but also health insurers have an important position in this". Participants further discussed that the government is more focused on economic interests than health interests, which restricts budget allocated to healthy and sustainable foods, illustrated by: *"think of Value Added Taxes, the economic interests outweigh the health interests"*. Furthermore, participants mentioned that the lack of prioritisation on the healthcare setting by the national government increases staff shortage and lowers available

time staff has for health care receivers, which in the end negatively influences the support for realizing a healthy and sustainable food environment.

Changeability and impact of leverage points
Twelve leverage points were identified (all leverage points are underlined and numbered in the causal loop diagram, Fig. 3). On the 10-point scale the three leverage points that received the highest score combination of impact and changeability are: (2) nutritional knowledge and skills of staff (impact = 7.0, changeability = 6.1), (12) lobby and agenda setting (impact = 7.3, changeability = 5.7), and (6) healthy and sustainable food is part of (preventive) care plan (impact = 7.4, changeability = 5.4). The impact and changeability scores for all leverage points are plotted and available via Additional file 3.

Actions for transition of the food environment
During session 2, participants formulated 40 actions based on the leverage points in the CLD, of which 10 actions were appraised on the *events* level of the ASM model, 22 actions on the *structures* level, 3 actions corresponded to the *goals* level and 5 actions to the *beliefs* level. The actions can be found in Additional file 4.

Evaluation of both GMB sessions
Overall, the results of the questionnaires showed that participants felt involved in both sessions with a mean score of 4.4 (SD = 0.5). Participants indicated that they were encouraged in systems thinking after the first session (M = 4.1, SD = 0.6) and obtained action awareness after the second session (M = 4.1, SD = 0.6). The open-end questions predominantly elucidated that participants wanted to share the outcomes of the sessions within their organization and that they required support from management level to implement the identified actions.

Follow-up summary: interviews after six, twelve months and time-line wall
Determining the accomplishments over the follow-up year through the interviews and time-line wall, participants highlighted various, small advancements towards improvement of the food environment, facilitated by the GMB sessions. Participants noted that the GMB sessions and outcomes played a role in raising awareness on the importance of a healthy and sustainable food environment, agenda setting, and the formulation of concrete plans to start improving the food environment. In one healthcare institution the sessions helped to (re)start the conversation on this topic with the management level: *"But it helps to start the conversation with the management - and I do notice that after the conversation we had, they seem to think that it is all well-founded - then it seems like we are being taken more seriously - so that's*

also very nice." (P14). Another participant highlighted that the study trajectory served as an important motivator for improving the food environment, acting as a catalyst for staying proactive. Some participants mentioned that the study activities emphasized the collaborative effort in improving the food environment, fostering a sense of unity rather than isolation, illustrated by: *"We do not act alone; there are several other healthcare institutions in the region who share similar intentions to undertake such endeavours." (P6).*

However, participants also mentioned that the study activities did not *directly* contribute to the initiation of concrete actions or improvements in the food environment, illustrated by *"we have not done much in the meantime" (P1)* or participants did not link or recall any changes to the study activities. Four healthcare institutions already started to improve their food environments before the sessions began (for example writing a new vision or outsourcing patient food service to in-house management) and the GMB sessions and outcomes served as a complementary effort, as illustrated by participants: *"We are moving in a certain direction and we will also take the knowledge and information of the sessions with us" (P19)* and *"we already had the intention to make improvements when it comes to nutrition" (P6).*

The main barriers for implementation of actions for improving the food environment that were mentioned by participants were: lack of time, lack of adequate budget or finances (e.g. because of inflation), no priority, no integration into daily tasks or daily health care, personnel changes (instable team), high workload, lack of communication and lack of support from management level or the entire organization or lack of having a forerunner to change the food environment As illustrated by a participant: *"It is so important that you have support, because then you also have the resources and manpower" (P14)* and *"Because we have a staff shortage and there are a lot of flexible workers at this moment nutrition is not the first thing to tackle" (P11).*

When participants were asked what they need in terms of resources to realize a healthy and sustainable food environment most participants indicated that they need (financial) support, people, forerunners, guidance (e.g. project leaders, tools for realizing a healthy and sustainable food environment, rules and policies within the healthcare institution but also from the government), peer support through learning from other healthcare institutions (e.g. by sharing best practices), and monitoring (e.g. by evaluation moments to assess the extent of change). Participants remarked the need of multidisciplinary collaboration and making integral decisions for the transition to a healthy and sustainable food environment. Also, having a vision and how to translate the vision to a plan were mentioned. One participant said:

"Besides policy at national level, there are also opportunities for policy at municipal level" (P13). Another participant suggested that the role of the government in creating a healthy and sustainable food environment in healthcare institutions should be the same role the government takes in quitting smoking. Another participant stressed the importance of handling autonomy, especially when individuals may not fully grasp the consequences of unhealthy foods. In such cases, maintaining autonomy is crucial, accompanied by the ability to provide guidance in decision-making, for instance providing a patient two healthy food options.

Discussion

This study obtained a comprehensive understanding of the system dynamics underlying the food environment in healthcare institutions. The collectively acknowledged systems map, included 30 factors, four subsystems including the patient, the healthcare organization, purchasing, procurement and budget and national governance and policy, and these subsystems included six feedback loops. Twelve leverage points for improving the healthcare food environment were identified with 'nutritional knowledge and skills of staff', 'lobby and agenda setting' and 'healthy and sustainable food is part of (preventive) care plan' perceived as most impactful and changeable. A total of 40 actions were formulated and appraised on the levels of the ASM, with most actions corresponding to the events and structures levels. The GMB sessions, outcomes and one-year follow-up trajectory did contribute to indirect actions that could lead to future system changes supportive of healthy food environments, including agenda setting and increased awareness of the need to improve the healthcare food environment. However, the study efforts did not *directly* contribute to action implementation that improved the food environment. To make further progress in the transition towards a healthy and sustainable food environment in long-term healthcare institutions, a longer time frame for follow-up and additional efforts towards the implementation of actions are required.

The study resulted in a systems map of the food environment in long-term healthcare institutions, which included four subsystems, each of which revealed several remarkable system dynamics. In the CLD subsystem 'the healthcare organization', most dynamics were found, with three feedback loops related to the factor 'support within the entire organization', indicating that organizational support, leadership and the presence of forerunners are crucial factors for realizing a healthy and sustainable food environment in the healthcare setting. This could be explained by delving into the deeper layers of the system, which encompass the beliefs and goals of the management, but also of the wider organization, as well as the norms and values around this topic that are essential for

initiating food environment policies and budget allocations for these policies [16]. The importance of support and forerunners was also found in other studies, showing that support and strong leadership are integral for successful implementation of actions for system change, and for broader stakeholder engagement [14, 31]. Other studies, including a systematic review, have shown that the implementation of other (non-food related) complex interventions in long-term care settings, also found that leadership, management support and forerunners to be key factors influencing successful change in healthcare settings [32, 33]. These findings indicate that it is important to start working on support and leadership for a healthy food environment on different levels within the healthcare organization before actually starting to change the food environment.

In the CLD subsystem 'the patient', the patients' demand for healthy and sustainable food occupies a central position with numerous factors influencing this demand (e.g. food marketing, patient's autonomy). This central position of the patient seems characterizing for the healthcare setting culture. The World Health Organization also defines healthcare quality as people-centred and organized to meet patients' needs [34]. The autonomy of patients is highly valued in healthcare contexts, providing patients with the right to self-determination and choice with regard to care, support and their treatment [35, 36]. For people with intellectual disabilities or psychogeriatric conditions receiving involuntary care the Dutch Act 'Wet Zorg en Dwang'[30] (Care and Coercion Act) describes and protects their rights, but also outlines that either care providers or client representatives can assist in making choices for them, when being unable to assess what is good for themselves. While this Act includes the administration of fluid, nutrition, medication and medical procedures, preventive measures (e.g., prohibit the overconsumption of unhealthy foods leading to weight gain) are not specified. A pivotal question that arises in these healthcare setting is whether health protection and preventive measures should be addressed, as not all patients are capable of making such health related choices themselves either [37].

The dynamics underlying the subsystem 'national governance & policy' showed that political priority is essential to formulate policies for establishing a healthy and sustainable food environment in the healthcare setting. To enhance priority, the influence of the lobby of civil society organizations was mentioned, a factor also found crucial in other studies for enhancing public health measures [38, 39]. However, civil society organizations have a much smaller sphere of influence and power and less resources for lobbying compared to commercial food industries [40, 41]. Improving the food environment in the healthcare setting has been given greater priority in

recent years as the Dutch government did set specific goals for improving the food environment in hospitals in the National Prevention Agreement, however specific objectives for other healthcare institutions were lacking [42]. Yet, after the GMB sessions, an agreement was signed by the Dutch government (Ministry of Health, Welfare and Sports) and several other parties (e.g. healthcare insurers, trade associations) aimed at keeping healthcare accessible, of good quality and affordable, including the goal to improve food environments in healthcare institutions for patients by 2030 [43]. This may further strengthen the needed priority to make substantial improvements to the food environments of healthcare institutions, and potentially extend the allocation of budget and to implement policies for a healthy and sustainable food environment, identified as essential for change in our study. Also from other studies it is known that sufficient financial resources and policies play a crucial role in realizing healthy and sustainable food environments [44, 45].

A myriad of actions were identified during the GMB sessions and this underlines the message that healthy and sustainable food environments in healthcare institutions cannot be created through single and isolated interventions. The actions were however predominantly developed at the lower levels of the system (events and structures levels) and to a lesser extent on the deeper levels of the system which provide greater potential for changing how the system functions (goals and beliefs levels). The results of our study indicated that, although we stimulated participants to think in systems, it was difficult for them to formulate actions that addressed deeper layers of the system and that it was easier to come up with actions that intervene in problems that are clearly visible. This is not surprisingly since people are often used to think in quick fixes and low hanging fruit actions within existing systems, as this is the common way and addresses actions that are often the easiest to implement. A potential explanation for the formulation of actions predominantly at the lower system levels could be that the duration of the GMB workshops in our study was too short for the devised methodologies of systems thinking. As people are not used to think in the deeper layers of systems, sufficient time should be allocated to support participants in this. Due to time constraints, certain components of the GMB scripts received less time than initially advised. A GMB study in New Zealand for improving fruit and vegetable intake in children, also explained that participants did not identify actions targeting the deeper levels of the systems, because the allowed time of 3-hour workshops was not enough for understanding system levers [22]. They recommended to add an additional phase to the GMB process for further identifying and implementing actions [22]. A study

by Conway-Moore et al. on co-creating obesity prevention policies with youth from different countries yielded similar findings, as most action ideas were formulated on the lowest system level, relating to adolescents own lived experience [46], and no action ideas were formulated on the higher levels of the system shifting goals and beliefs. Participants in another GMB study, to improve obesity related behaviours in adolescents in the Netherlands, succeeded in the formulation of actions targeting higher system levels. However, in this study they formed separate action groups per action theme, that met regularly and there was more guidance on the application of systems thinking [47]. Another potential explanation for the formulation of actions predominantly at the lower system levels could be that we did not invite the right group of stakeholders, for example the system architects of healthcare institutions of which it is known that these people have mandate to enact change, e.g. directors, managers, policy makers. Our sample consisted mainly of participants fulfilling a rather executive role, where strategic thinking might not be the core aspect of their job. Furthermore, it is recommended to appropriately identify, approach and engage a very wide group of stakeholders (not only invite people who are responsible for food and beverages) for the GMB workshops, including system architects such as governmental stakeholders (e.g. policy makers) and external parties (e.g. caterers, suppliers).

The GMB process in this study was successful in encouraging systems thinking, and using GMB to collaboratively understand the system was a valuable approach. However, advancing from action ideas to action implementation remained lagging in the one year follow-up. First of all, it could potentially be explained by the fact that the GMB sessions were held with a variety of healthcare institutions with only one or two participants per institution and probably an insufficient amount of forerunners and system architects, people needed for real action implementation [16, 48]. Furthermore, going from systems thinking (GMB approach) to actual systems acting requires recognition of the people in charge of making decisions and a clear guidance on how to implement system based changes [49, 50]. Yet, main barriers for progress identified were lack of priority, time, budget and support, showing that substantial efforts at this organizational level are required. Another likely explanation is that the time frame of our evaluation was too short, since action implementation for system change is a prolonged endeavour because systems change at a gradual pace, which can take up to several years, which was far beyond the reach of this study [38]. To illustrate, a recent review into GMB use in public health and healthcare settings, showed that more substantial system changes need time and were only observed after 5-years of follow-up [21]. The short term outcomes of GMB were associated

with insights (individual level learning), consensus and strengthening relationships, which are in line with our outcomes after our one-year follow-up. Therefore, a long-term follow-up evaluation would be valuable to assess system changes in the food environment of healthcare institutions.

This study provides a novel contribution to the literature towards the application of a systems approach in a real-life setting to understand the system dynamics underlying the food environment in the healthcare setting. Strengths include the inclusion of participants from a wide range of healthcare institutions, serving a diversity of health care receivers, who were able to collaboratively create a shared understanding of the system underlying the food environment in healthcare institutions. The participants were all part of the system and spoke the same language and jargon and could comprehend and complement each other in discussions despite the differences in functions and type of healthcare institutions. This shows that the method is applicable across healthcare institutions and throughout the healthcare landscape. Another strength is the follow-up trajectory to evaluate the GMB process and progress towards action implementation, as a follow-up trajectory is often not included in GMB studies.

The present study also includes some limitations. First, the participants may not be representative for the entire healthcare institution and therefore we lack the view of all actors involved that may have provided a different perspective on the system underlying the healthcare food system. Although we included a variety of stakeholders (e.g., facilities managers, dietitians), even a more diverse group including the system architects (e.g. management level, board level), would have been preferred. Second, the GMB method involved stakeholders from five different healthcare institutions, making the developed systems collectively acknowledged and applicable for multiple types of healthcare institutions. Yet, it could have been more useful to apply the GMB method and follow-up trajectory of action implementation within each separate healthcare institution because then it can be employed for that specific healthcare institution and ensure that a wide range of stakeholders from that institution is engaged during the trajectory. Moreover, we only conducted a one-year follow-up study while systems changes require a longer period of time [21]. However, due to budgetary, personnel and time constraints we were unable to prolong the follow-up period. Another limitation was the challenge for the facilitators and researcher of taking notes during the GMB sessions, therefore we recommend recording the sessions in the future. A final limitation was that the GMB process and study trajectory required a substantial time investment from the participants, resulting that not all participants were involved in all study activities.

The results of this study also yield implications for governmental policy formulation, e.g. specific for the food environment in the healthcare setting and tailored to different types of care. The progress evaluation towards action implementation can be used to strategically invest in resources to overcome barriers and to foster actual sustainable implementation of actions for transitioning the food environment in the healthcare setting. A recommendation for future research is to assess the generalizability of the outputs to see whether the created systems map and identified actions are representative for other healthcare institutions, or that the process of the creation of the systems map is unique and should be repeated in each setting. Another recommendation for future research is to explore how developing a CLD and creating action ideas could lead to long-lasting implementation of actions that can reorientate the system – from systems thinking to systems acting.

Conclusions

This study gained a comprehensive, collectively acknowledged understanding of the system dynamics underlying a healthy and sustainable food environment in healthcare institutions. The results underscore the importance of crafting a coherent set of actions that addresses various factors and underlying mechanisms to initiate systemic change, with due attention given to action implementation. The one-year evaluation showed that actual action implementation and system change remained challenging. The potential of systems-based solutions should be identified collectively with all stakeholders (system architects and users, e.g. policy makers, health care staff, suppliers) and future research should ascertain if it fosters impactful change in the food environment in healthcare settings. Long-term follow-up research is needed to explore how to come from action ideas to implementation for improvement of the food environment in healthcare institutions.

Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

Supplementary Material 4

Declarations

Ethics approval and consent to participate
The study was approved by the Social Sciences Ethics Committee of Wageningen University & Research (ethical approval number: 2021-38-Wierda) and the study complies with the Netherlands Code of Conduct for Research Integrity. All participants provided informed consent to participate. The study followed all procedures in accordance with the relevant guidelines and regulations of the Declaration of Helsinki [52].

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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