Systems Thinking in Communities:

Understanding the Causes of Inactivity, Poor Diet/Nutrition, and Childhood Obesity in Charleston, West Virginia

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KEYS 4 HealthyKids

Unlocking the Doors to a Better Tomorrow

Introduction

KEYS 4 HealthyKids is one of 49 community partnerships participating in the national *Healthy Kids, Healthy Communities* program of the Robert Wood Johnson Foundation (www.healthykidshealthycommunities.org). The purpose of this *KEYS 4 HealthyKids* project was to introduce systems thinking at the community level by identifying the essential parts of the Charleston, West Virginia system and how the system influences policy and environmental changes to promote healthy eating and active living as well as to prevent childhood obesity. To accomplish this goal, community partners and residents participated in a group model building session and discussions. The group model building exercises were designed by staff from Transtria LLC and the Social System Design Lab at Washington University in St. Louis, Missouri as part of the *Evaluation of Healthy Kids, Healthy Communities* funded by the Robert Wood Johnson Foundation. These exercises actively involved a wide range of participants in modeling complex systems and provided a way for different representatives (e.g., local foundations, community-based organizations, government agencies, academic institutions, and community members) to better understand the systems (i.e., dynamics and structures) in the community (see the *Healthy Kids, Healthy Communities Group Model Building Facilitation Handbook*, www.transtria.com/hkhc). Overall, the evaluation was designed to assess policy, system, and environmental changes as a result of the community partnerships' efforts to increase healthy eating and active living in order to reduce childhood obesity.

Charleston, West Virginia: Background and Local Participation

The capital city of Charleston, West Virginia is the most populated city in the state with a population of 51,400. Charleston is the county seat of Kanawha County, with a population of 193,063. Many of the residents in the surrounding county and region commute to Charleston daily, doubling its population during the work day.

The KEYS 4 HealthyKids partnership focused on two low-income neighborhoods within Charleston: East End and West Side. These neighborhoods were targeted because of their similar disparities and current neighborhood revitalization efforts. Both neighborhoods lacked safe places to play and access to affordable, healthy food. The partnership initially focused its efforts around two elementary schools in these neighborhoods:

- Piedmont Elementary was home to 376 students, 80% of whom participate in the free and reduced-price lunch program.
- West Side Elementary was home to 409 students, 97% of whom participate in the free and reduced-price lunch program.

Starting in 2012, the partnership expanded its efforts to additional Charleston neighborhoods and communities throughout Kanawha County and nine surrounding counties.

In 1995, concerned about the health of the county's residents, the hospitals and many area organizations joined together to form the Kanawha Coalition for Community Health Improvement. Under the guidance of health assessments conducted every three years, the coalition and their steering committee formed an obesity workgroup and a physical activity workgroup. Realizing the need for targeted policy and environment change, the obesity workgroup added several new partners and began meeting as the current partnership, KEYS 4 HealthyKids, in December of 2008 in parallel with their grant application to RWJF. Charleston Area Medical Center Health Education and Research Institute (CAMC Institute) was the lead agency for the KEYS partnership. The CAMC Institute, affiliated with the Charleston Area Medical Center, was established in 1996 for charitable, scientific, and educational purposes. The main purpose of the partnership was to increase access to fresh and affordable foods and increasing physical activity opportunities within the community. Initially, the partnership teams met frequently to establish the work plan but as the work plan took shape, partnership meetings shifted to key leader and steering committee meetings rather than entire membership meetings. A core of 10-15 partners regularly participated and others partners engaged when the work complemented their strategy area. Both the Project Director and Project Coordinator shared many of the same roles, guiding the partnership and ensuring partnership work aligned with the workplan and that the workplan was built upon proven, valid methods. The partnership created five teams, headed by a member of the steering committee, to guide their partnership strategies.

The partnership and capacity building strategies of *KEYS 4HealthyKids* included:

- **KEYS Youth Council:** KEYS 4 HealthyKids collaborated with the local YMCA to form the KEYS Youth Council in 2010. The council focused on childhood obesity prevention and advocacy and was comprised of middle school students from Kanawha County.
- **Community Action Toolkit:** The partnership created a KEYS 4 HealthyKids Toolkit to guide participating communities and organizations' efforts in implementing policy and environmental change. KEYS offered technical assistance and developed a Peer Learning Network to provide ongoing support.

The healthy eating and active living strategies of *KEYS 4 HealthyKids* included:

- **Child Care Nutrition and Physical Activity Standards:** KEYS 4 HealthyKids partnered with 18 child care centers to improve nutrition and physical activity standards in child care settings. Eighteen centers participated to improve standards using the Nutrition and Physical Activity Self-Assessment for Child Care Centers (NAP SACC) tool.
- **Parks and Play Spaces:** The partnership successfully advocated for and supported implementation of new parks and play spaces and modifications to existing ones. Many of the repairs and park improvements were a result of the Youth Council's advocacy and involvement with the Charleston City Council Parks and Recreation Committee and the Parks and Recreation Department.
- **City Comprehensive Planning:** Partnership staff provided extensive input into the City of Charleston's new comprehensive plan, Imagine Charleston. Adopted in 2013, Imagine Charleston was the first Charleston comprehensive plan to incorporate a health section that included healthy eating and active living. Policies recommended by KEYS and adopted into the final plan included access to healthy, affordable food, and access to places for families and children to be active.
- **Access to Healthy Food:** KEYS collaborated with community members, schools, and child care centers to improve access to healthy and affordable food in a wide variety of areas including farmers' markets, food pantries, community gardens, and school and youth gardens.

For more information on the partnership, please refer to the Charleston case report (http://www.transtria.com/hkhc_case_reports.php).

Systems Thinking in Communities: Charleston, West Virginia

"Systems thinking" represents a range of methods, tools, and approaches for observing the behaviors of a system (e.g., family, community, organization) and how these behaviors change over time; changes may occur in the past, present, or future. Figure 1 illustrates a system of policies, environments, local collaborations, and social determinants in Charleston, West Virginia that influence healthy eating, active living, and, ultimately, childhood obesity. This system and the dynamics within the system are complicated with many different elements interacting.

Models, such as Figure 1, provide a way to visualize all the elements of the system and their interactions, with a focus on causal relationships as opposed to associations. Through the model, specific types of causal relationships, or feedback loops, underlying the behavior of the dynamic system, can be identified to provide insights into what is working or not working in the system to support the intended outcomes (in this case, increases in healthy eating and active living, and decreases in childhood overweight and obesity). In system dynamics, the goal is to identify and understand the system feedback loops, or the cause-effect relationships that form a circuit where the effects "feed back" to influence the causes.

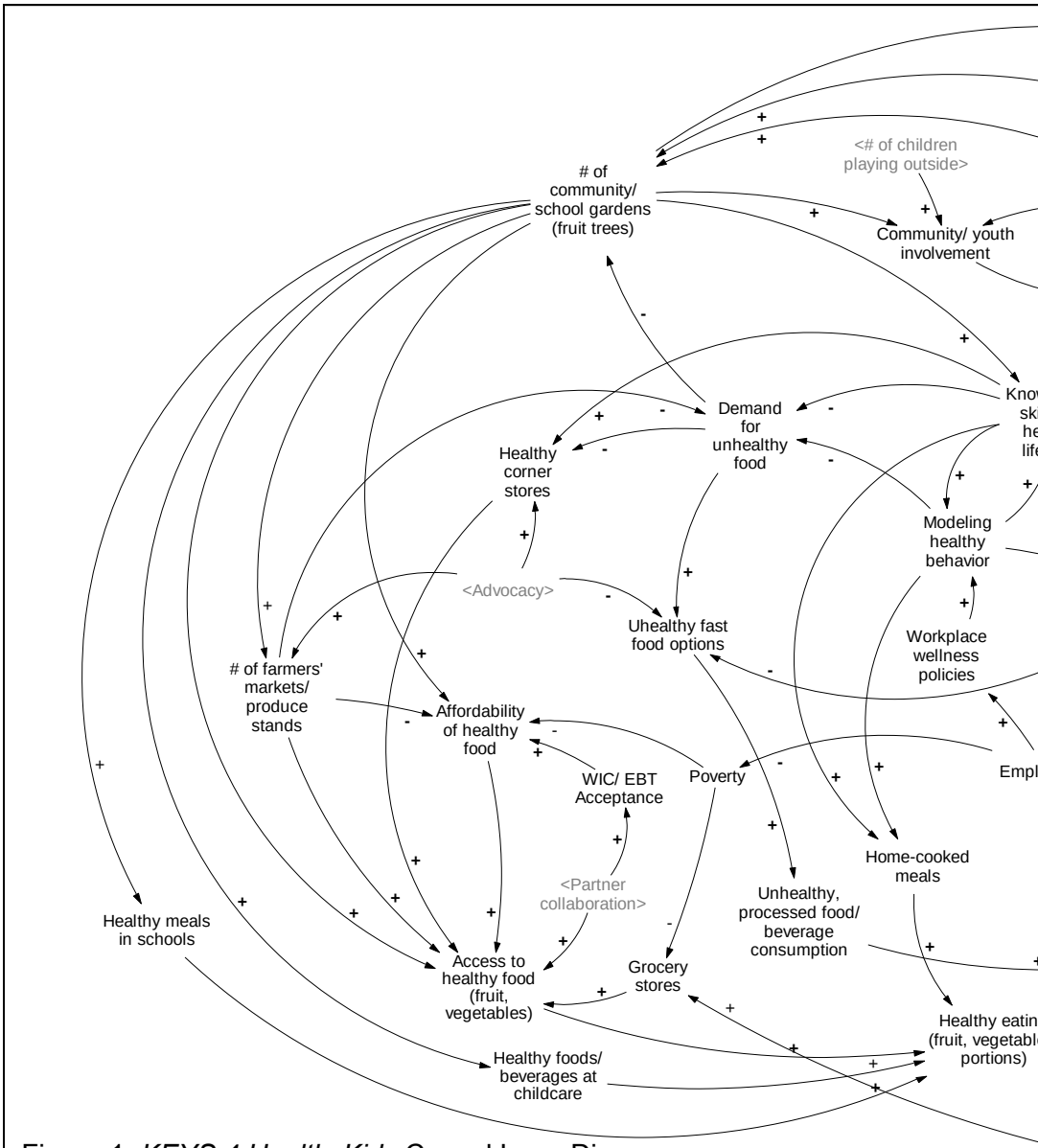


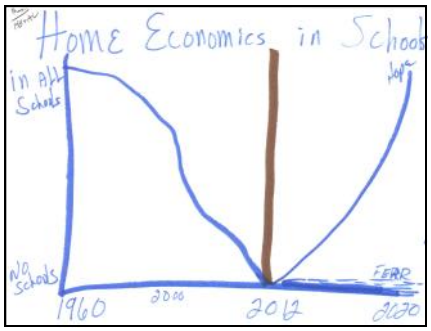
Figure 1: *KEYS 4 HealthyKids* Causal Loop Diagram

Group Model Building

Members of the *KEYS 4 HealthyKids* partnership participated in a group model building session in July, 2012 and generated this system. also referred to as a causal loop diagram (Figure 1). Participants in the group model building session included representatives from local foundations, community-based organizations, government agencies, academic institutions, and community members. The group model building session had two primary activities: 1) a Behavior Over Time Graph exercise; and 2) a Causal Loop Diagram (or structural elicitation) exercise.

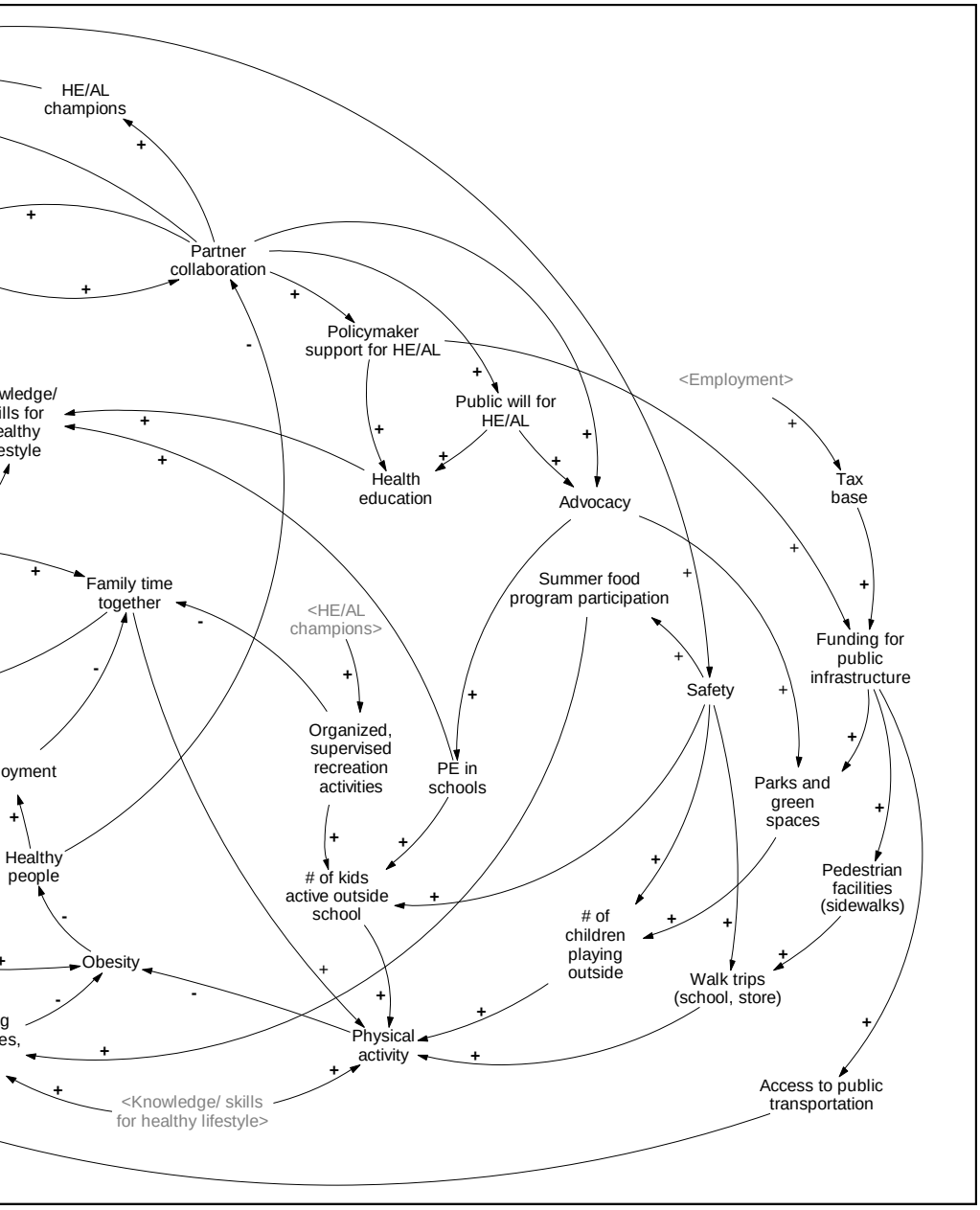
<u>Behavior Over Time Graphs</u>

To identify the range of things that affect or are affected by policy, system, and environmental changes in Charleston related to healthy eating, active living, and childhood obesity, participants designed graphs to name the influences and to illustrate how the influences have changed over time (past, present, and future). In this illustration, there has been a decrease in home economics offered in school since 1960 to 2012 with the hope that into the



future home economics will increase and be offered in schools to educate youth on cooking with healthy foods (see behavior over time graph previous page bottom right).

Each graph is a tool to increase the use of common, specific language to describe *what* is changing in the community as well as *when*, *where*, and *how* it is changing. The graphs capture participants' perceptions of the influence, or variable, and through the graph, the participant tells their story. These perceptions are based on actual data or evidence, or they are part of the participants' lived experience.



Causal Loop Diagram

To examine the relationships among the variables from the behavior over time graphs, participants worked together and with facilitators to develop a causal loop diagram. In Figure 1, the words represent variables of quantities that can increase and decrease over time (i.e., the behavior over time graphs). These variables are influenced by other variables as indicated by the lines with arrows. The lines with arrows represent causal relationships - this is what is known about the system and how it behaves.

For instance, there are many feedback loops influencing or influenced by the number of community and school gardens in this causal loop diagram. One feedback loop is: number of community and school gardens → knowledge and skills for healthy lifestyles → demand for unhealthy food → number of community and school gardens. A second feedback loop is: number of community and school gardens → community and youth involvement → partner collaboration → number of community and school gardens.

What is important to notice in these examples is that there are two different feedback loops interacting simultaneously to influence or to be influenced by number of community and school gardens. Some variables may increase number of community and school gardens while other variables limit number of community and school gardens. Determining the feedback loop or loops that dominate the system's behavior at any given time is a more challenging problem to figure out, and ultimately, requires the use of computer simulations.

Based on this preliminary work by the *KEYS 4 HealthyKids* partnership, this "storybook" ties together the behavior over time graphs, the participants' stories and dialogue, and feedback loops from the causal loop diagram to understand the behavior of the system affecting health in Charleston, West Virginia and to stimulate greater conversation related to Charleston's theory of change, including places to intervene in the system and opportunities to reinforce what is working. Each section builds on the previous sections by introducing concepts and notation from systems science.

Causal Loop Diagram for the Childhood Obesity System

The causal loop diagram (CLD) represents a holistic system and several subsystems interacting in Charleston, West Virginia. In order to digest the depth and complexity of the diagram, it is helpful to examine the CLD in terms of the subsystems of influence. Because of this project's focus on healthy eating, active living, and childhood obesity, this system draws attention to a number of corresponding subsystems, including: healthy eating policies and environments (red), active living policies and environments (blue), health and health behaviors (orange), partnership and community capacity (purple), and social determinants (green).

From the group model building exercises, several variables and causal relationships illustrated in Figure 2 were identified within and across subsystems. This section describes the subsystems in the CLD.

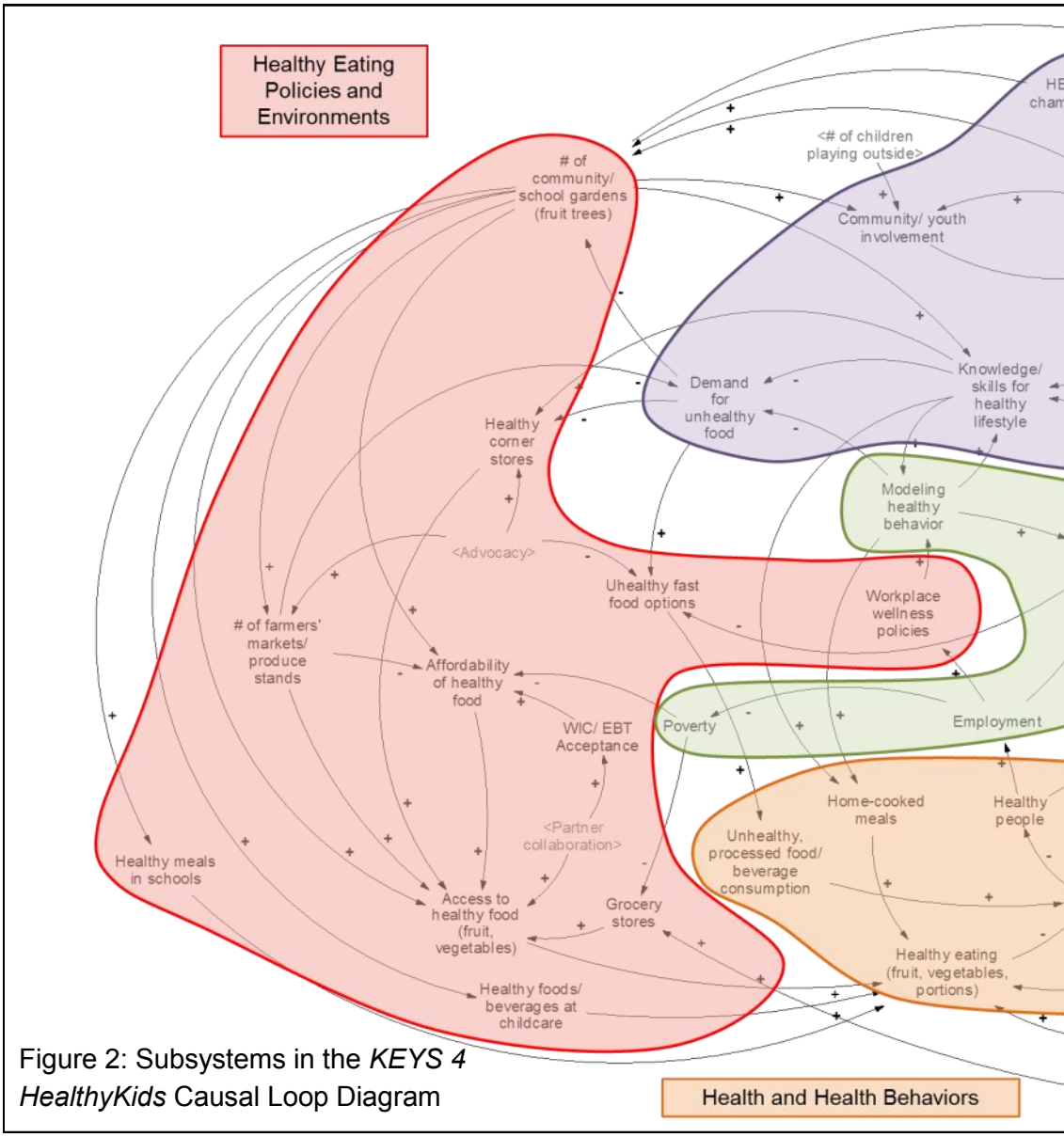


Figure 2: Subsystems in the *KEYS 4 HealthyKids* Causal Loop Diagram

<u>Healthy Eating Policies and Environments (Red)</u>

The healthy eating policy and environmental subsystem includes food production (e.g., number of community and school gardens), food distribution and procurement (e.g., WIC and EBT acceptance), and food retail (e.g., number of farmers' markets and produce stands). During the behavior over time graphs exercise, the participants generated thirteen graphs related to policy or environmental strategies (e.g., healthy corner stores, healthy meals in schools) or contexts (e.g., affordability of healthy food) that affected or were affected by the work of *KEYS 4 HealthyKids*. The variables represent participants' conversations from the behavior over time graph and causal loop diagram exercises.

<u>Active Living Policies and Environments (Blue)</u>

The active living policy and environmental subsystem includes design, planning, construction, and enforcement or maintenance related to access to opportunities for active transportation and recreation. For this topic, the group model building participants developed eight graphs related to policy or environmental strategies (e.g., PE in schools) or contexts (e.g., access to public transportation) that affected or were affected by the partnership's work.

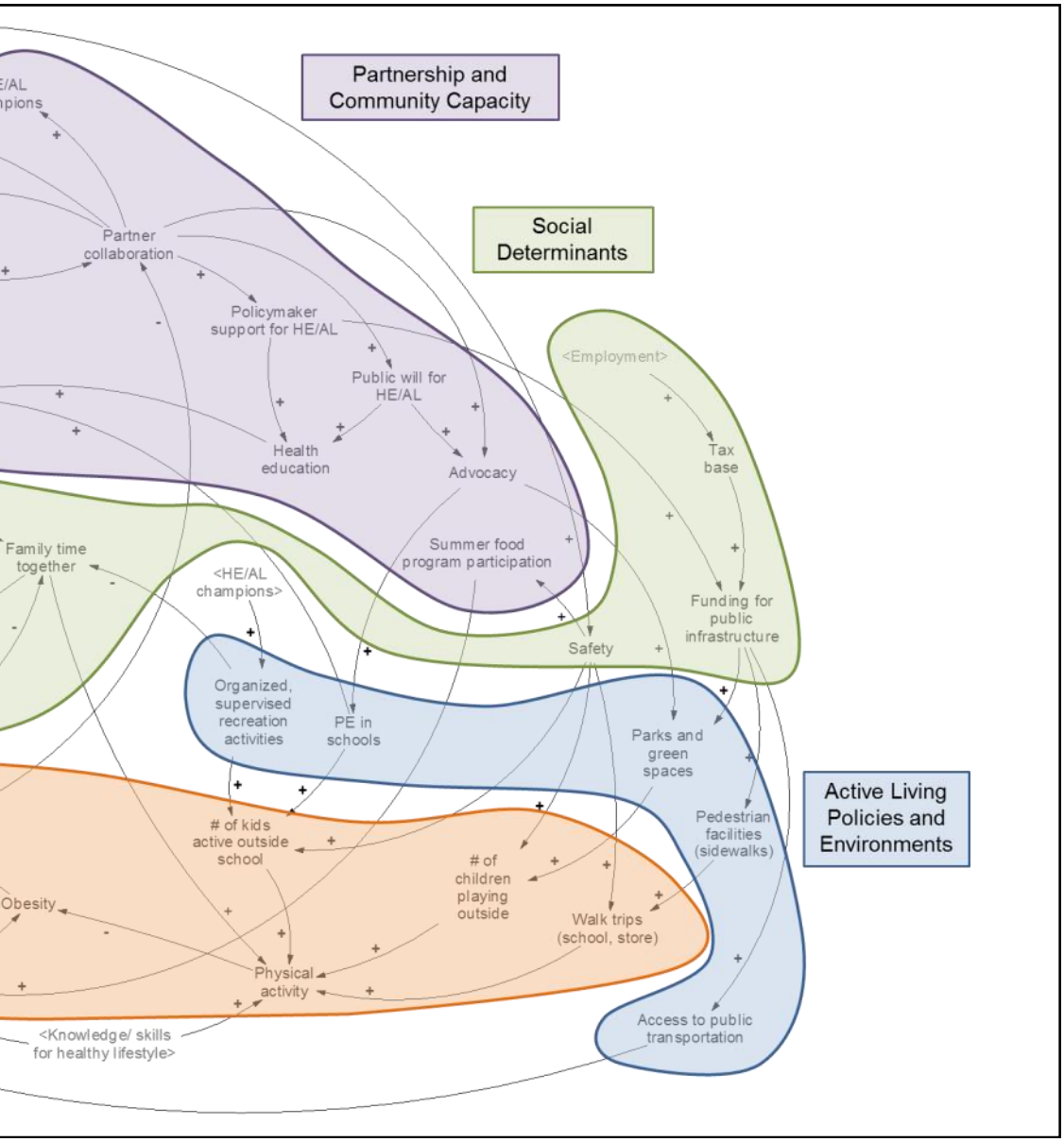
<u>Health and Health Behaviors (Orange)</u>

The subsystem for health and health behaviors includes health outcomes (e.g., obesity), health behaviors

(e.g., healthy eating, physical activity), and behavioral proxies or context-specific behaviors (e.g., walk trips, home-cooked meals).

Partnership and Community Capacity

The partnership and community capacity subsystem refers to the ways communities organized and rallied for changes to the healthy eating and active living subsystems. For instance, *KEYS 4 HealthyKids* collaborated with the local YMCA to form the KEYS Youth Council in 2010. The council focused on childhood obesity prevention and advocacy and was comprised of middle school students from Kanawha County. This subsystem also includes community factors outside the partnership that may influence or be influenced by their efforts, such as knowledge and skills for healthy lifestyles or policymaker support for healthy eating and active living.



Social Determinants

Finally, the social determinants subsystem denotes societal conditions (e.g., employment, funding for public infrastructure, tax base) and psychosocial influences (e.g., safety, family time together) in the community that impact health beyond the healthy eating and active living subsystems. In order to achieve health equity, populations and subgroups within the community must have equitable access to these resources and services.

Each one of these subsystems has many more variables, causal relationships (arrows), and feedback loops that can be explored in greater depth by the *KEYS 4 HealthyKids* partners or by other representatives in Charleston, West Virginia. Using this CLD as a starting place, community conversations about different theories of change within subsystems may continue to take place. For instance, these participants identified interest in understanding more about the relationships among partner collaboration, policymaker support for healthy eating and active living, and parks and green spaces.

The next sections begin to examine the feedback loops central to the work of *KEYS 4 HealthyKids*. In these sections, causal relationships and notations (i.e., arrows, “+” signs, “-” signs) from Figure 2 will be described to increase understanding about how systems thinking and modeling tools can work in communities to increase understanding of complex problems that are continuously changing over time, such as childhood obesity. At the end of this CLD storybook, references to other resources will be provided for those interested in more advanced systems science methods and analytic approaches.

KEYS Youth Council Feedback Loop

To simplify the discussion about feedback loops, several loops drawn from the *KEYS 4 HealthyKids* CLD (see Figures 1 and 2) are highlighted in Figures 3-7. While the CLD provides a theory of change for the childhood obesity prevention movement in Charleston, West Virginia, each feedback loop tells a story about a more specific change process.

Causal Story for Feedback Loop

Story A: In this case , the story is about the KEYS Youth Council (green highlighted loop in Figure 3). Charleston, West Virginia the youth council was critical in advocating for changes within the parks system. Participants described how with more community and youth involvement, there was an increase in partner collaboration, which increased advocacy efforts. As more advocacy efforts took place, there was an increase in parks and green spaces opportunities. In turn, with more parks and green spaces, there is more children playing outside, which increases community and youth involvement.

Story B: While the preceding story reflected a positive scenario for Charleston, West Virginia, the same feedback loop also tells the opposite story. With less community and youth involvement, there was a decrease in partner collaboration, which decreased advocacy efforts. As less advocacy efforts took place, there was a decrease in parks and green spaces opportunities. In turn, with less parks and green spaces, there is less children playing outside, which decreases community and youth involvement.

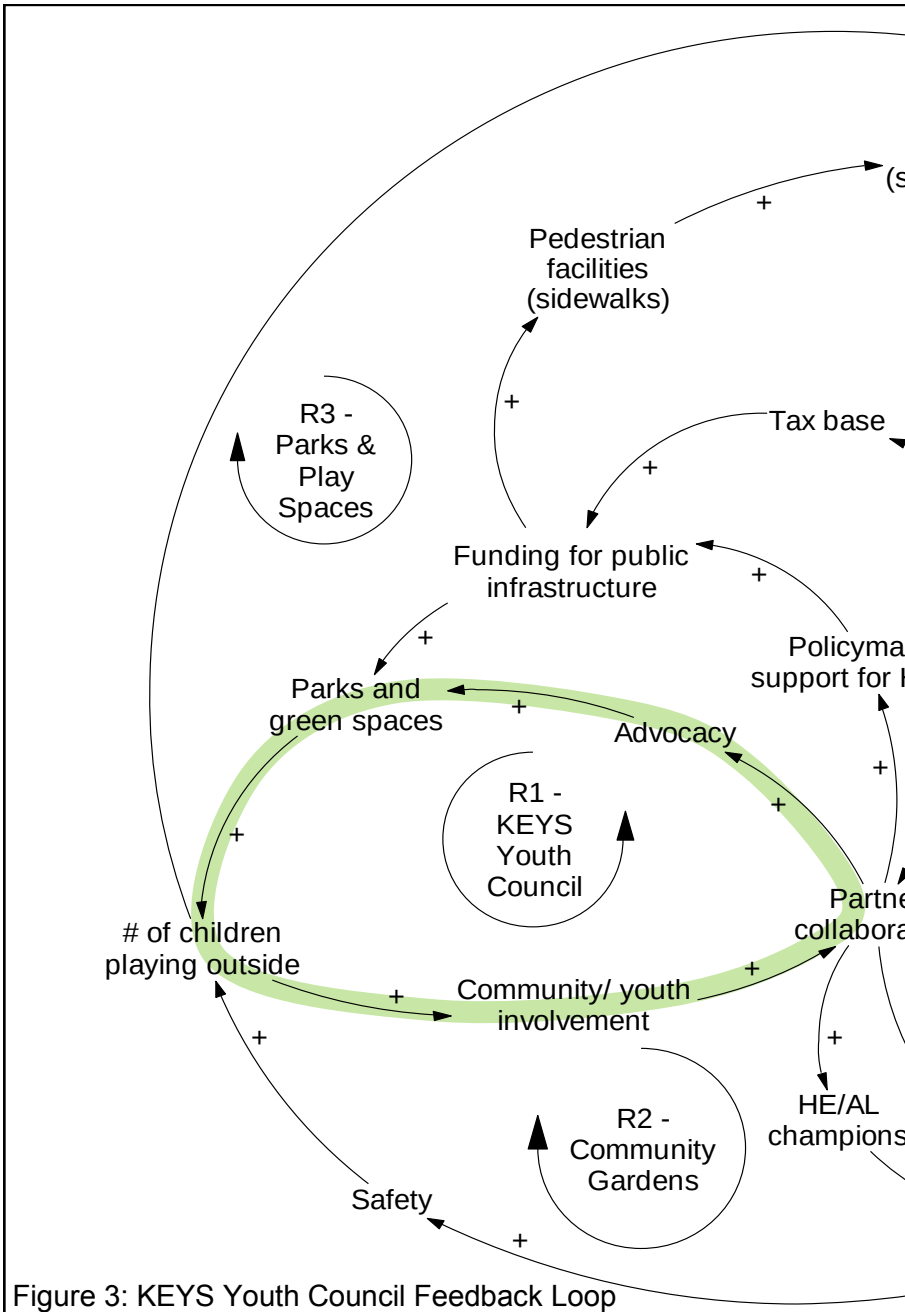


Figure 3: KEYS Youth Council Feedback Loop

Reinforcing Loop and Notation

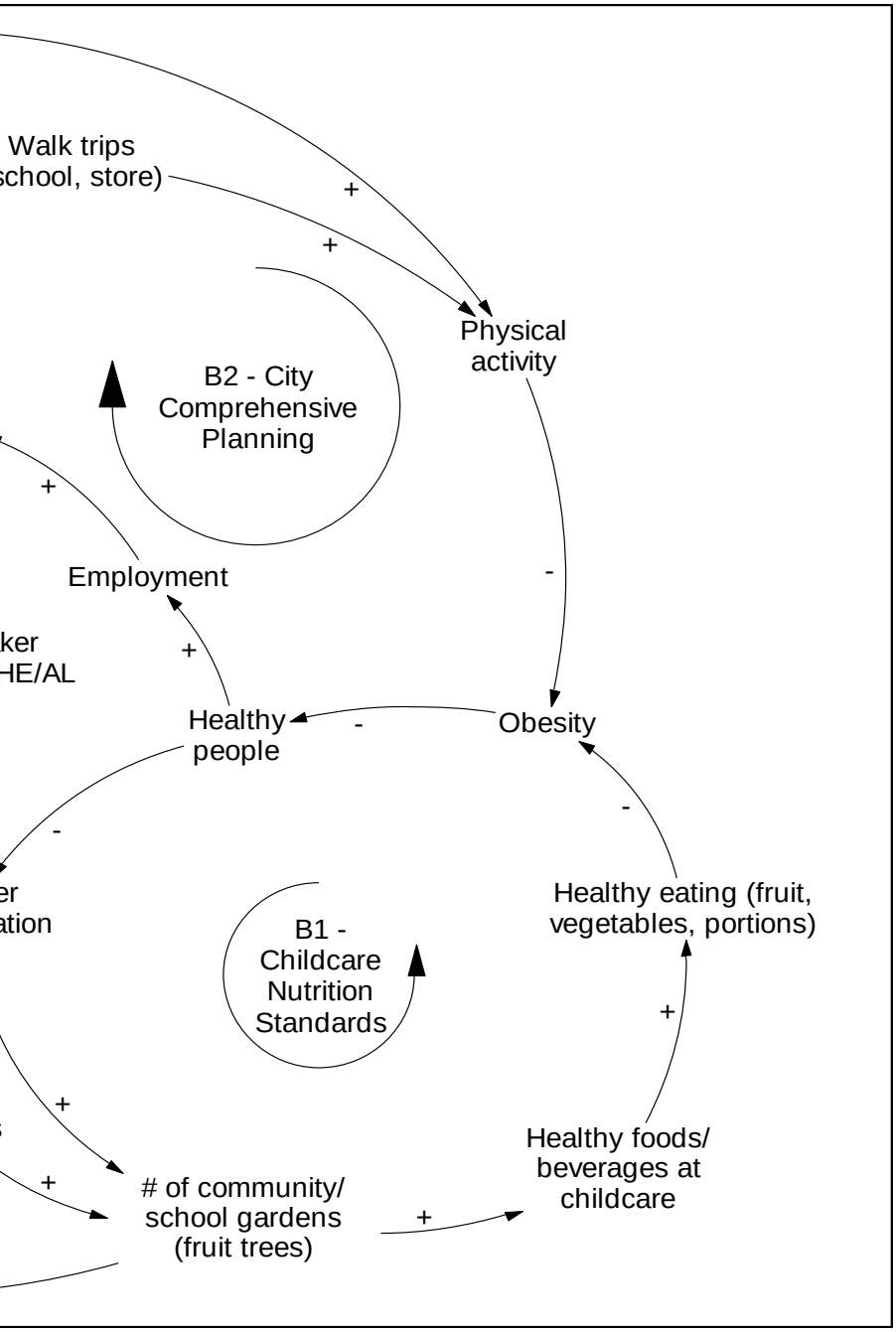
These stories represent a reinforcing loop, and the notation in the feedback loop identifies it as a reinforcing loop (see "R1— KEYS Youth Council" and green highlighted loop in Figure 3). The words represent variables of quantities that increase and decrease as illustrated in the stories above. These variables change over time and are influenced by other variables as indicated by the arrows. Each arrow represents a causal relationship, and the plus and minus signs on the arrows indicate whether or not the influence of one variable on another variable (1) increases/adds to (plus or "+" sign), or (2) decreases/removes from the other variable (minus or "-" sign).

"Back in the olden days, after church and different activities, families would actually go into a field and play ball. And that's not happening anymore. It's sort of like nobody has the time for it, but still today, if you go in a field with a ball and a couple of kids, you'll have 15-20 in about 1-1/2 hours because they will come out and join. It's just, it's finding a field and getting out there. So we need to do more to plan those kinds of things and make them happen." (Participant)

These signs are referred to as polarities. In a reinforcing loop, the effect of an increase or decrease in a variable continues through the cycle and returns an increase or decrease to the same variable, respectively.

Looking specifically at the "+" or "-" notation, a feedback loop that has zero or an even number of "-" signs, or polarities, is considered a reinforcing loop. Balancing loops, with an odd number of "-" signs in the loop, are another type of feedback loop and are referenced in the next sections.

In isolation, this reinforcing loop represents a virtuous cycle in Story A as these assets positively support one another, or a vicious cycle in Story B as these challenges perpetuate a downward spiral. Yet, the influence of community and youth involvement likely levels off at some point. To understand what specifically leads to the leveling off of community and youth involvement, it may be helpful for the partners in Charleston, West Virginia to consider other variables that influence or are influenced by community and youth involvement. In addition, it is important to remember that this reinforcing loop is only one part of the larger CLD (see Figures 1 and 2), and the other loops and causal relationships can have an impact on the variables in this loop.

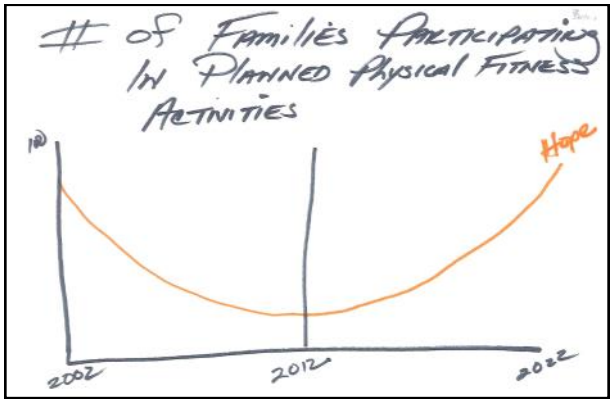


<u>System Insights for *KEYS 4 HealthyKids*</u>

Participants identified a decrease in the number of families participating in planned physical fitness activities since 2002 to 2012 with the hope that the number of families participating in planned physical fitness activities will change and increase into the future (see behavior over time graph bottom right).

From the systems thinking exercises, several insights can inform the KEYS Youth Council, including:

- Non-traditional partners with expertise in community and youth engagement and organizing enhance more traditional advocacy approaches targeting policy– and decision-makers.
- Incorporation of efforts to increase community knowledge and empowerment generates more community engagement to bolster advocacy efforts (e.g., programmatic and promotional efforts to complement policy, system, and environmental changes can enhance overall advocacy).



Child Care Nutrition Standards Feedback Loop

Given the introduction to feedback loops and CLD notation in the previous section, this discussion of the feedback loop highlighted in orange in Figure 4 expands on the concepts and notation, and highlights child care nutrition standards.

Causal Story for Feedback Loop

Story A: In this case, the story is about child care nutrition standards. With more healthy foods and beverages at child care facilities, there is an increase in healthy eating particularly fruits and vegetables. As more youth are eating fruits and vegetables in child care facilities, there is a reduction in obesity, which increase the number of healthy people. As more people are healthy, there is a decrease in partner collaboration to work creating opportunities for people to be healthier. With less partner collaboration, there is less community and school gardens, which decreases healthy foods and beverages in child care facilities.

Story B: Alternatively, with less healthy foods and beverages at child care facilities, there is a decrease in healthy eating particularly fruits and vegetables. As less youth are eating fruits and vegetables in child care facilities, there is an increase in obesity, which decreases the number of healthy people. As fewer people are healthy, there is an increase in partner collaboration to work creating opportunities for people to be healthier. With more partner collaboration, there is more community and school gardens, which increases healthy foods and beverages in child care facilities.

Balancing Loop and Notation

Unlike the KEYS Youth Council loop in Figure 3, this loop has three "-" signs or polarities; because this is an odd number, it is a balancing loop (see B1—Child Care Nutrition Standards in Figure 4).

In a balancing loop, the effect of the variables tend to create more of a stable trend over time, as opposed to one that is continually increasing or decreasing. This effect continues through the cycle and returns a stabilizing influence to the original variable, respectively.

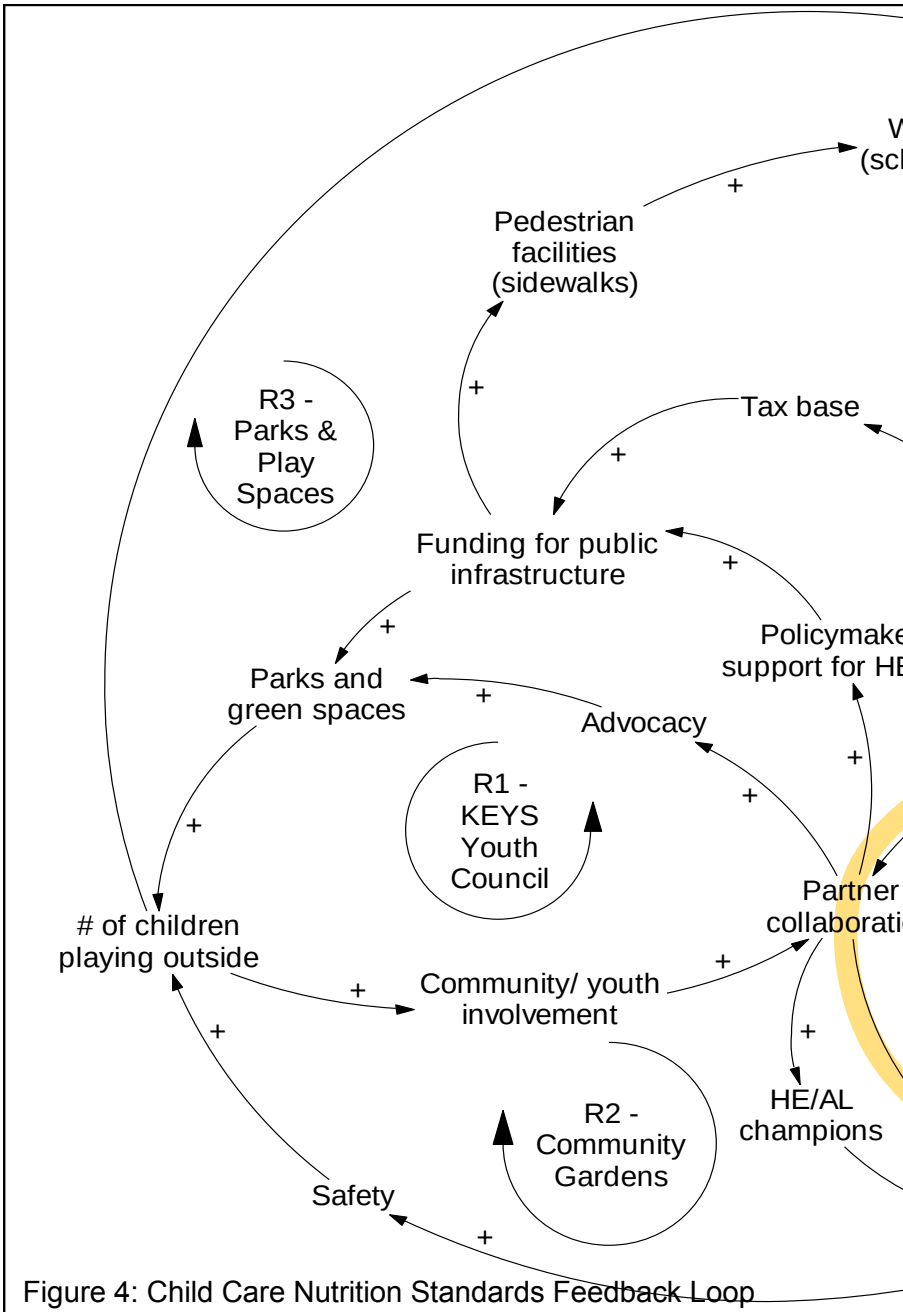


Figure 4: Child Care Nutrition Standards Feedback Loop

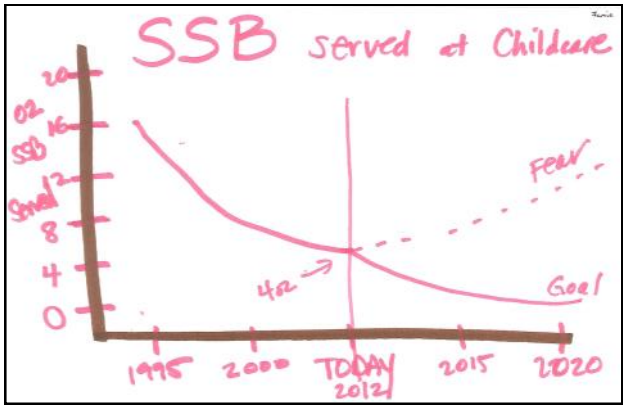
Some of these causal relationships may have more immediate effects (e.g., healthy foods and beverages at child care facilities influence on healthy eating) and other relationships may have delayed effects (e.g., healthy eating influence on obesity). This delayed

"The biggest outcry for the [childcare] centers is how to get the fresh fruits and vegetables. Most shop once a month or every other week, so they would have fresh produce the first four or five days, and then the next week none, you know because of storage and because of other [reasons]." (Participant)

effect is noted using two hash marks through the middle of the arrow line (not included in Figure 4).

System Insights for *KEYS 4 HealthyKids*

In the behavior over time graphs, participants identified a decrease in the amount of sugar sweetened beverages served at child care facilities since 1995 to 2012 with the hope that the amount of sugar sweetened beverages served at



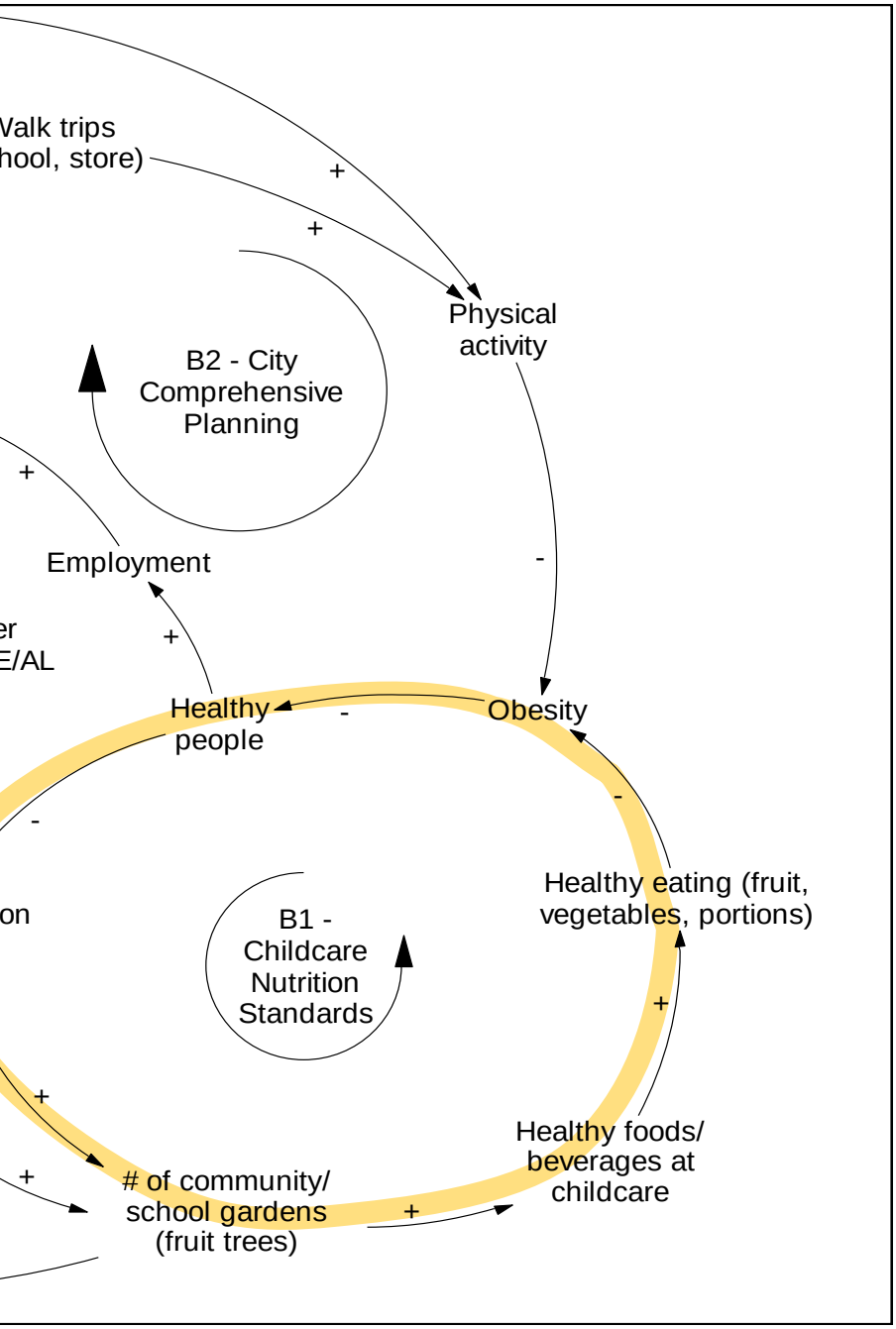
child care facilities will continue to decrease into the future (see behavior over time graph top right). Participants also described a very slight increase in the number of children eating fresh fruits and vegetables since 2000 to 2012 with the hope that the number of children eating fresh fruits and vegetables will drastically increase into the future (see behavior over time graph bottom right).

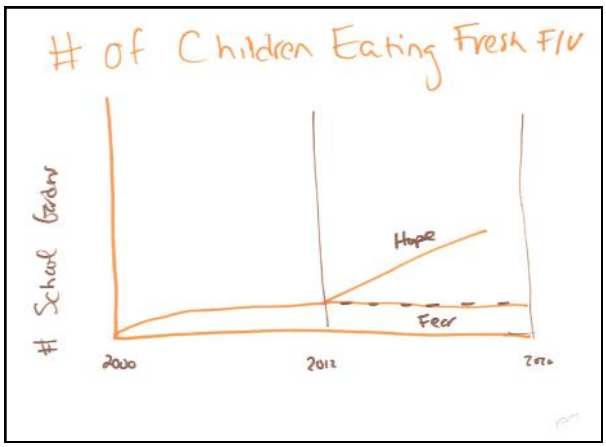
System insights can inform the partnership's next steps with child care nutrition standards, including:

- Community gardens and urban agriculture designed to enhance youth and community engagement can introduce new fruits and vegetables to youth and residents particularly through child care and school settings.
- Higher rates of childhood obesity increase resident engagement and attention to this issue; as rates of obesity decline, it may be difficult to maintain these advocacy efforts in order to sustain improvements that have been made.

In addition to these insights, systems thinking can also help to pose key questions for assessment and evaluation, including:

- What is the quantity and quality of food vendors within a one-mile radius of child care center and after school programs (e.g., access to fruits and vegetables, access to junk foods)?





Community Gardens Feedback Loop

Highlighted in blue in Figure 5, the community gardens feedback loop represents one of the *KEYS 4 HealthyKids* strategies to increase healthy eating in Charleston, West Virginia.

Causal Story for Feedback Loop

Story A: With more community and school gardens, there is an increase in safety in the community. As there is more community safety, there is an increase in the number of children playing outside, which increases community and youth involvement. With more community and youth involvement, there is an increase in partner collaboration, which increases the number of healthy eating and active living champions. With more healthy eating and active living champions, there is an increase in the number of community and school gardens.

Story B: Alternatively, with less community and school gardens, there is a decrease in safety in the community. As there is less community safety, there is a decrease in the number of children playing outside, which decreases community and youth involvement. With less community and youth involvement, there is a decrease in partner collaboration, which decreases the number of healthy eating and active living champions. With less healthy eating and active living champions, there is a decrease in the number of community and school gardens.

Reinforcing Loop and Notation

Similar to the first loop (see Figure 3), this one also represents a reinforcing loop (all "+" signs). In addition, it includes causal relationships representing more immediate effects (e.g., number of children playing outside influence on community and youth involvement), and, potentially, delayed effects.

Story A provides a good illustration of the reason why it is not advantageous to separate the feedback loops from the causal loop diagram (see Figures 1-2). For instance, while

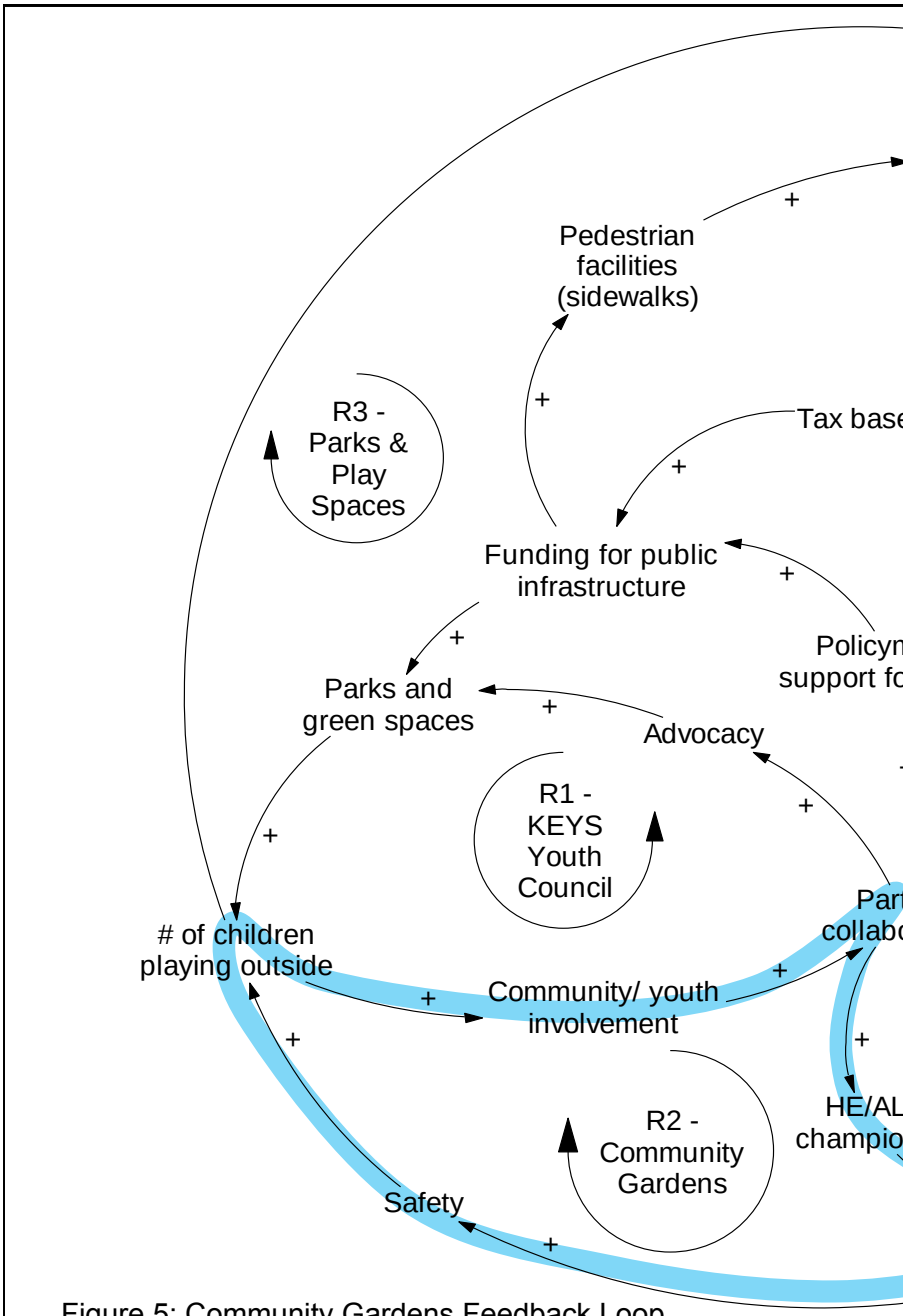
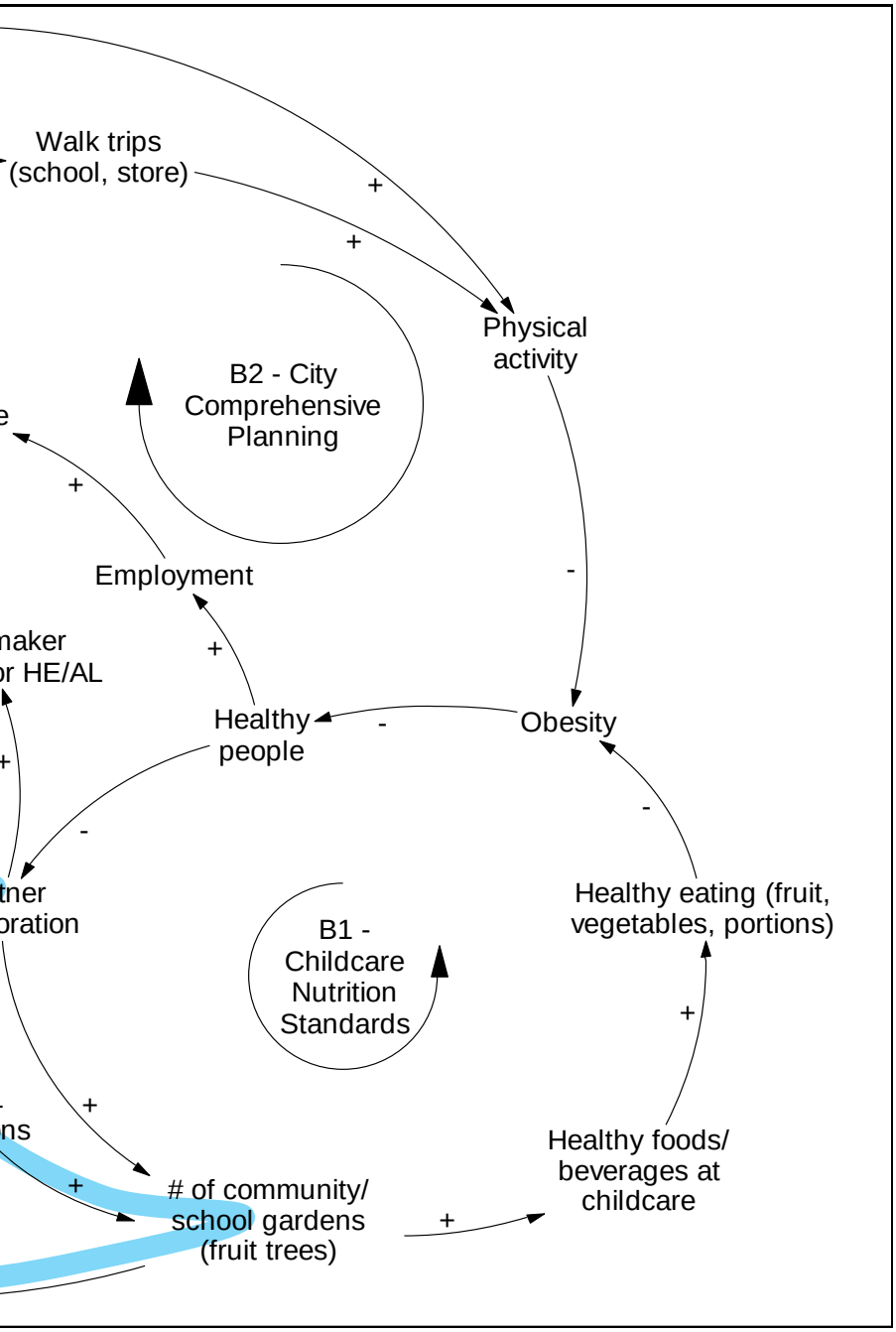


Figure 5: Community Gardens Feedback Loop

"I can remember when vendors brought fruits and vegetables into communities and sold them. And then, all of a sudden, those fruits and vegetables became too expensive for the consumer in the economically-challenged community. Working with community gardens has been a real eye-opening experience to me; the number of people getting involved and the fact that the people aren't depriving their children of fruits and vegetables. We've gone through that period when [fruits and vegetables] weren't available and we've got a generation of kids who weren't exposed to them, didn't know they existed, and now we're reintroducing them into the families and I'm thinking that the community gardens is going to play a big role in that reintroduction." (Participant)

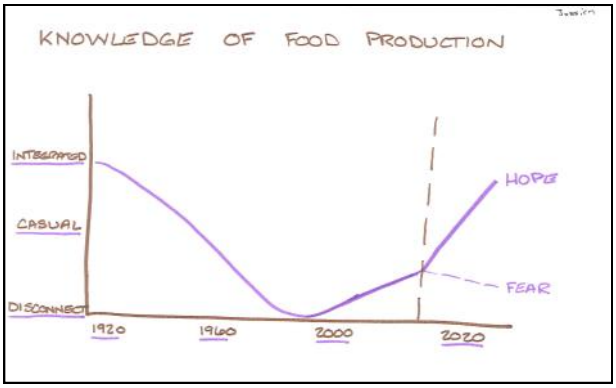
the number of community and school gardens may have an influence on safety, many other factors influence safety. In this case, examining this loop without the context of the other variables and loops may lead to inappropriate conclusions.

System Insights for *KEYS 4 HealthyKids*



community gardens or farms for a neighborhood or urban area?

- What factors influence neighborhood safety (e.g., rates of crime, violent actions)? Are these the same factors that influence perceptions of neighborhood safety? What are the actual rates of crime and violence as compared to perceptions?



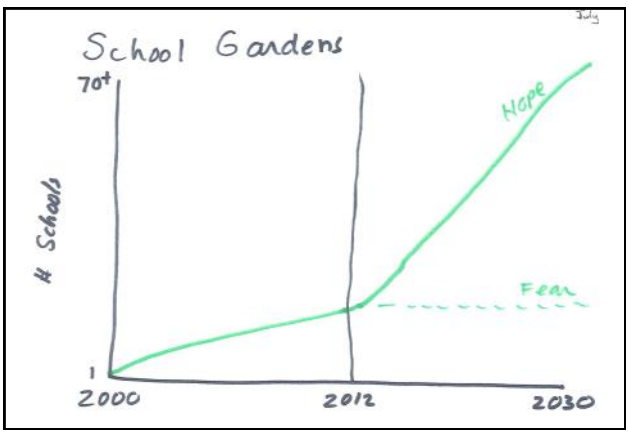
In the behavior over time graphs exercise, participants described a decrease in the knowledge of food production since 1920 to 2012 with the hope that knowledge of food production will increase into the futures (see behavior over time graph top right). Participants also identified an increase in the number of school gardens since 2000 to 2012 with the hope that the number of school gardens will continue to increase into the future (see behavior over time graph bottom right).

System insights for the partnership's community gardens efforts include:

- Urban gardens and farms increase neighborhood revitalization and limit or reverse suburban sprawl as residents feel less vulnerable to crime or violence in urban areas; by drawing residents back into more dense, urban neighborhoods, the gardens and farms minimize geographic isolation in suburban dwellings.
- Addressing community safety is a necessary step to support use of outdoor recreation facilities.

In addition to these insights, systems thinking can also help to pose key questions for assessment and evaluation, including:

- What is the optimal number of school or



Parks and Play Spaces Feedback Loop

Highlighted in red in Figure 6, the parks and play spaces feedback loop represents one of the *KEYS 4 HealthyKids* strategies to increase active living in Charleston, West Virginia.

Causal Story for Feedback Loop

Story A: With more strategic efforts to utilize funding for public infrastructure, there is an increase in the parks and green spaces available in the community. With more parks and green spaces available, there are more children playing outside, which increases physical activity. With more residents and children being physically active, there is a reduction in obesity. As there is less obesity, there is more healthy people, which increases the number of people employed as they are not out of work because of health concerns. With an increase in employment, there is an increase in the local tax base, which increases funding for public infrastructure.

Story B: Alternatively, with less strategic efforts to utilize funding for public infrastructure, there is a decrease in the parks and green spaces available in the community. With less parks and green spaces available, there are less children playing outside, which decreases physical activity. With less residents and children being physically active, there is an increase in obesity. As there is more obesity, there is less healthy people, which decreases the number of people employed as they are out of work because of health concerns. With a decrease in employment, there is a decrease in the local tax base, which decreases funding for public infrastructure.

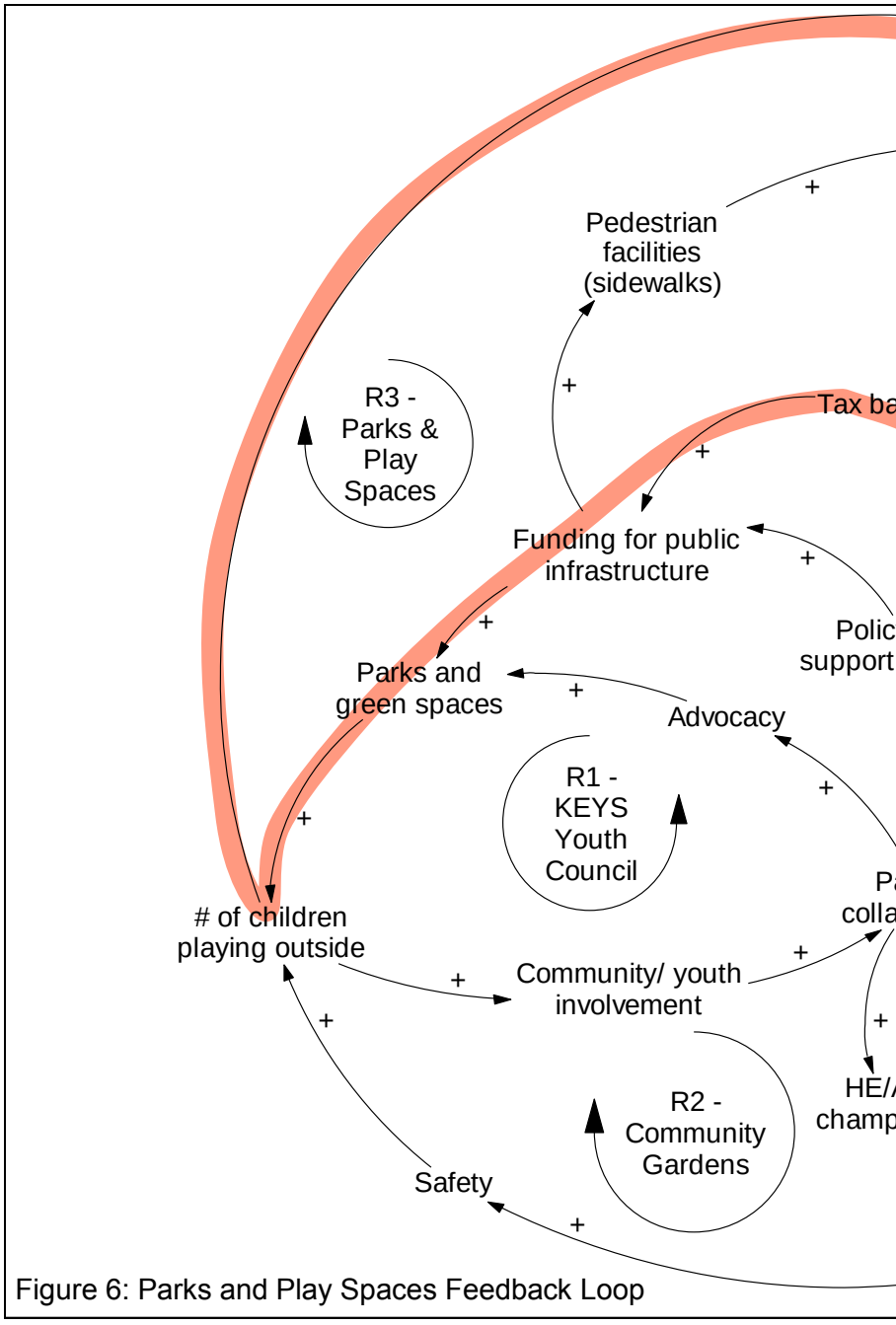


Figure 6: Parks and Play Spaces Feedback Loop

Reinforcing Loop and Notation

Similar to the previous loops (see Figure 3 & 5), this is a reinforcing loop (all "+" signs). In addition, it includes causal relationships representing more immediate effects (e.g., number of children playing outside influence on physical activity), and, potentially, delayed effects (e.g., physical activity influence on obesity).

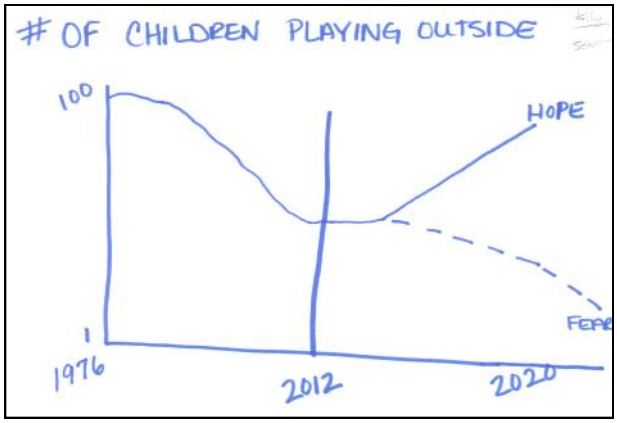
System Insights for *KEYS 4 HealthyKids*

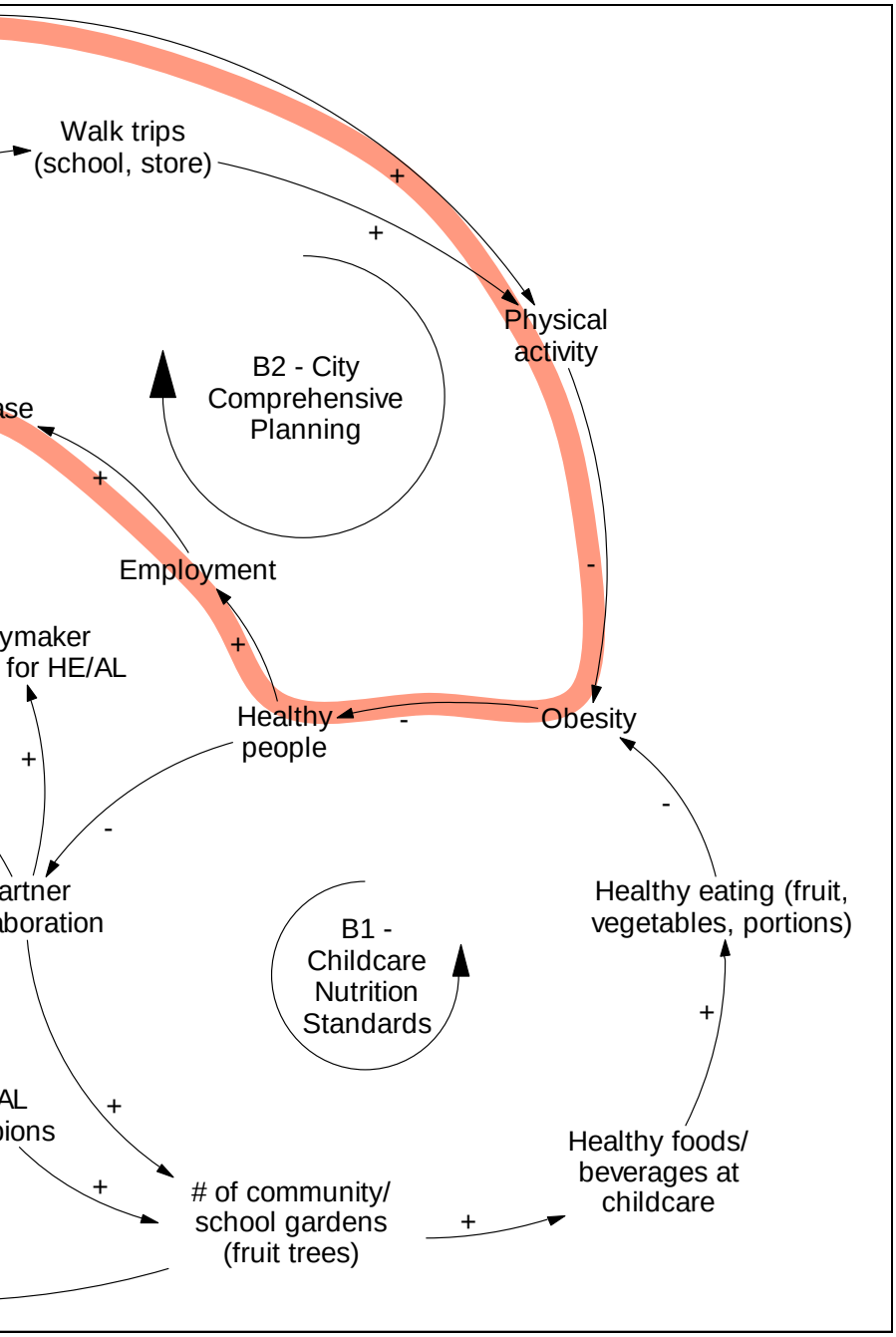
In the behavior over time graphs exercise, participants described a decrease in the number of children play outside since 1976 to 2012 with the hope that the number of children playing outside will increase into the future (see behavior over time graph next page top right).

"The fear is that if we don't clear up some of these environmental issues, such crime, and that funding, in terms of land grants and whatever keeps our community centers and maybe some of the activities in our local churches going, that it goes away and we could see a decrease if we don't address those other issues." (Participant)

System insights for the partnership's parks and play spaces efforts include:

- Public recreation facilities increase the health of community members and beautify their neighborhoods.
- Communities capitalize on local parks, trails, and recreation facilities as places to convene neighbors and community representatives to advocate for changes (e.g., more funding for infrastructure) to support access to healthy eating and active living resources and services in the community; these are also good places to increase voter registration (e.g., booths in the park or along the trail).





- Over time, the loss of hours of physical activity per day has not yet reversed in response to efforts to add a few parks and trails to the area, so these efforts require greater focus and intensity to increase park and trail use.
- Jobs are an essential ingredient to creating equity (reducing disparities and discrimination), safety, and a stable economy.
- A stronger economy provides the resources necessary to create an efficient public infrastructure that gets more people in the community walking and biking and utilizing parks and green spaces.

In addition to these insights, systems thinking can also help to pose key questions for assessment and evaluation, including:

- What factors can increase employers' and policy-makers' attention to safe parks, trails, and outdoor facilities?
- What are the optimal numbers and types of public recreation facilities for a neighborhood or urban area?

City Comprehensive Planning Feedback Loop

Highlighted in yellow in Figure 7, the city comprehensive planning feedback loop represents one of the *KEYS 4 HealthyKids* strategies to increase active living in Charleston, West Virginia.

Causal Story for Feedback Loop

Story A: With more strategic efforts to utilize funding for public infrastructure, there are more pedestrian facilities including sidewalks. With more pedestrian facilities, there is an increase in the number of walking trips residents take to school or to the store, which increase physical activity. With more physical activity, there is a reduction in obesity, which increases the number of healthy people. With more healthy people, there is a decrease in partner collaboration. With less partner collaboration, there is a decrease in policymaker support for healthy eating and active living, which decreases funding for public infrastructure.

Story B: Alternatively, with less strategic efforts to utilize funding for public infrastructure, there are less pedestrian facilities including sidewalks. With less pedestrian facilities, there is a decrease in the number of walking trips by residents, which decreases physical activity. With less physical activity, there is an increase in obesity, which decreases the number of healthy people. With less healthy people, there is an increase in partner collaboration. With more partner collaboration, there is an increase in policymaker support for healthy eating and active living, which increases funding for public infrastructure.

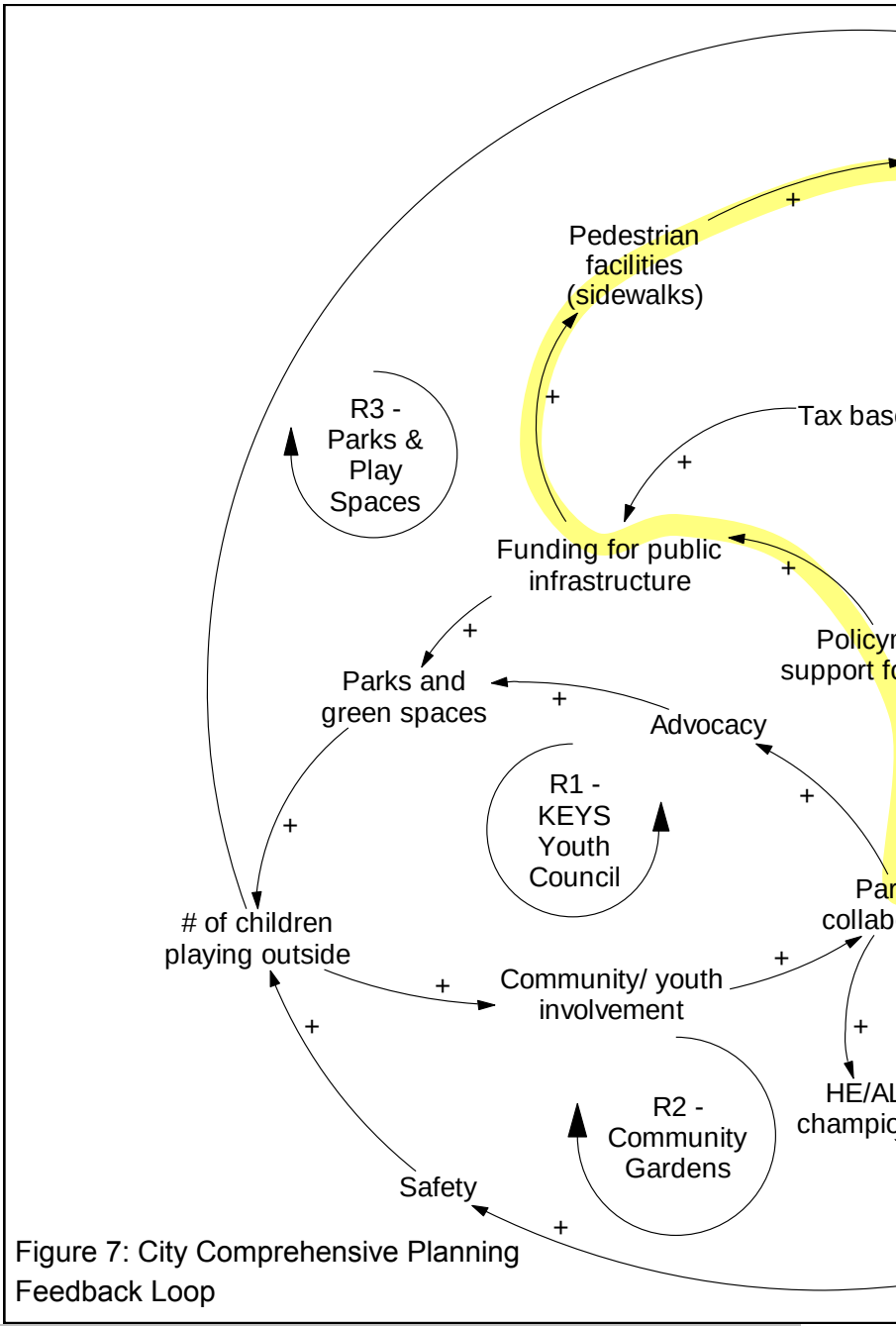


Figure 7: City Comprehensive Planning Feedback Loop

Balancing Loop and Notation

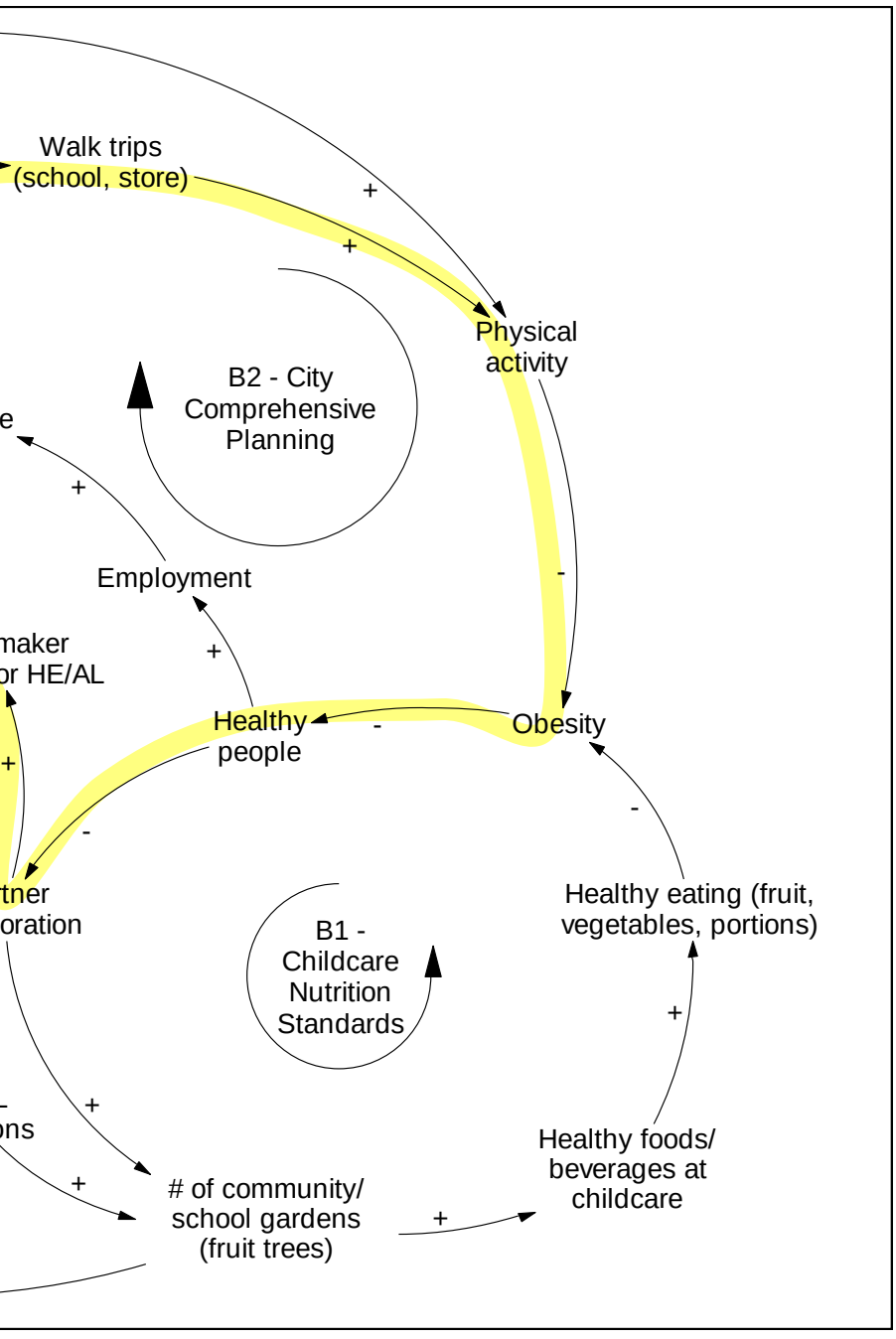
Similar to the previous loops (see Figure 4), this is a balancing loop (three "-" signs). In addition, it includes causal relationships representing more immediate effects (e.g., pedestrian facilities influence on walk trips), and, potentially, delayed effects (e.g., physical activity influence on obesity).

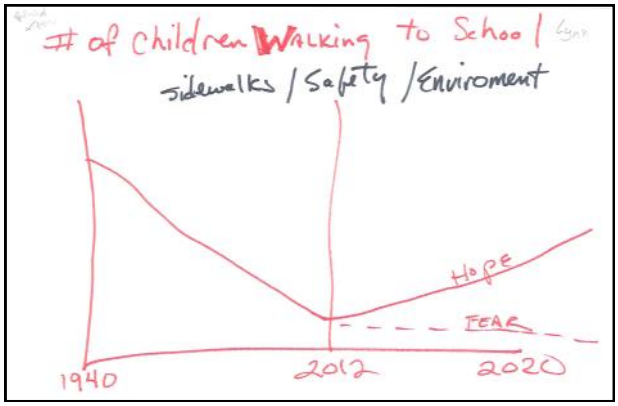
System Insights for *KEYS 4 HealthyKids*

In the behavior over time graphs exercise, participants described a decrease in the number of children walking to school since 1940 to 2012 with the hope that the number of

"In 2005, our legislature adopted the Healthy Lifestyle Act which, for the first time, had minutes assigned for physical education at the elementary and middle schools. WVU looked at the percent of schools that were able to implement that policy and it was fairly low; the main issues were facilities and staff. Some of the schools with the multipurpose rooms couldn't meet the minutes. So what I envision here is that more and more schools will be able to meet those minutes or exceed them, but my fear is, again, as you know with the competition for resources, etc., that those numbers will go down." (Participant)

children walking to school will change and increase into the future (see behavior over time graph top right). However, participants also described a slight increase in the attention to issues from legislature with the hop that attention to issues related to childhood obesity, healthy eating, and active living will drastically increase into the future (see behavior over time graph bottom right).



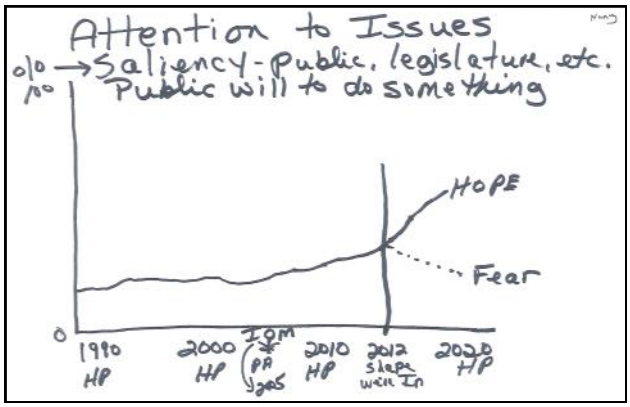


System insights for the partnership's city comprehensive planning efforts include:

- Strategic city planning efforts that incorporate active living (and healthy eating) elements has a better chance of funding being allocated to make infrastructure improvements and create more opportunities for sustainability.
- Improvements to and expansion of public transit and bike infrastructure has a good return on investment by stimulating economic development and private investment in the local community.
- Efforts to build political will — particularly support from policy-makers — for improvements to transit and bike infrastructure benefit from economic data forecasting how short-term expenditures have substantive long-term

In addition to these insights, systems thinking can also help to pose key questions for assessment and evaluation, including:

- What streets have accommodations for pedestrians, bicyclists, and drivers? Are they safe for all users? What is still needed (e.g., traffic calming measures, more sidewalks and bike lanes)?
- What are successful funding structures to incentivize partnership and collaboration?



Opportunities for Systems Thinking in Charleston, West Virginia

This storybook provided an introduction to some basic concepts and methods for systems thinking at the community level, including: causal loop diagrams, variables and shadow variables, causal relationships and polarities, reinforcing feedback loops, and balancing feedback loops, among others. For the *KEYS 4 HealthyKids* partners, this storybook also summarized the healthy eating, active living, partnership and community capacity, social determinants, and health and health behaviors subsystems in the Charleston causal loop diagram as well as six specific feedback loops corresponding to the partnership's primary strategies.

This causal loop diagram reflects a series of conversations among partners and residents from 2011 to 2013. Some discussions probed more deeply into different variables through the behavior over time graphs exercise, or causal relationships through the causal loop diagram exercise.

This represented a first attempt to collectively examine the range of things that affect or are affected by policy, system, and environmental changes in Charleston, West Virginia to promote healthy eating and active living as well as preventing childhood overweight and obesity.

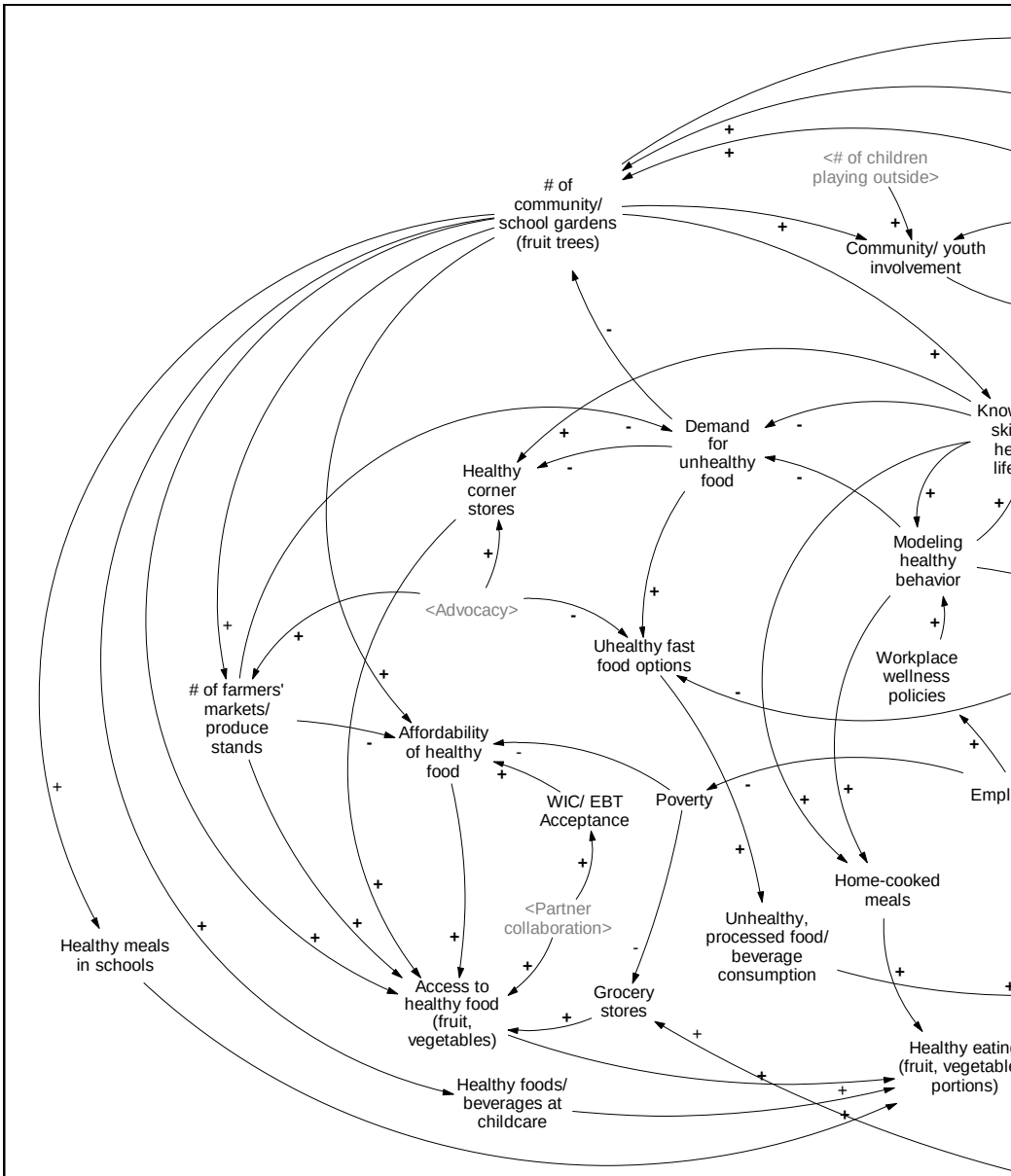


Figure 8: *KEYS 4 HealthyKids* Causal Loop Diagram

Yet, there are several limitations to this storybook, including:

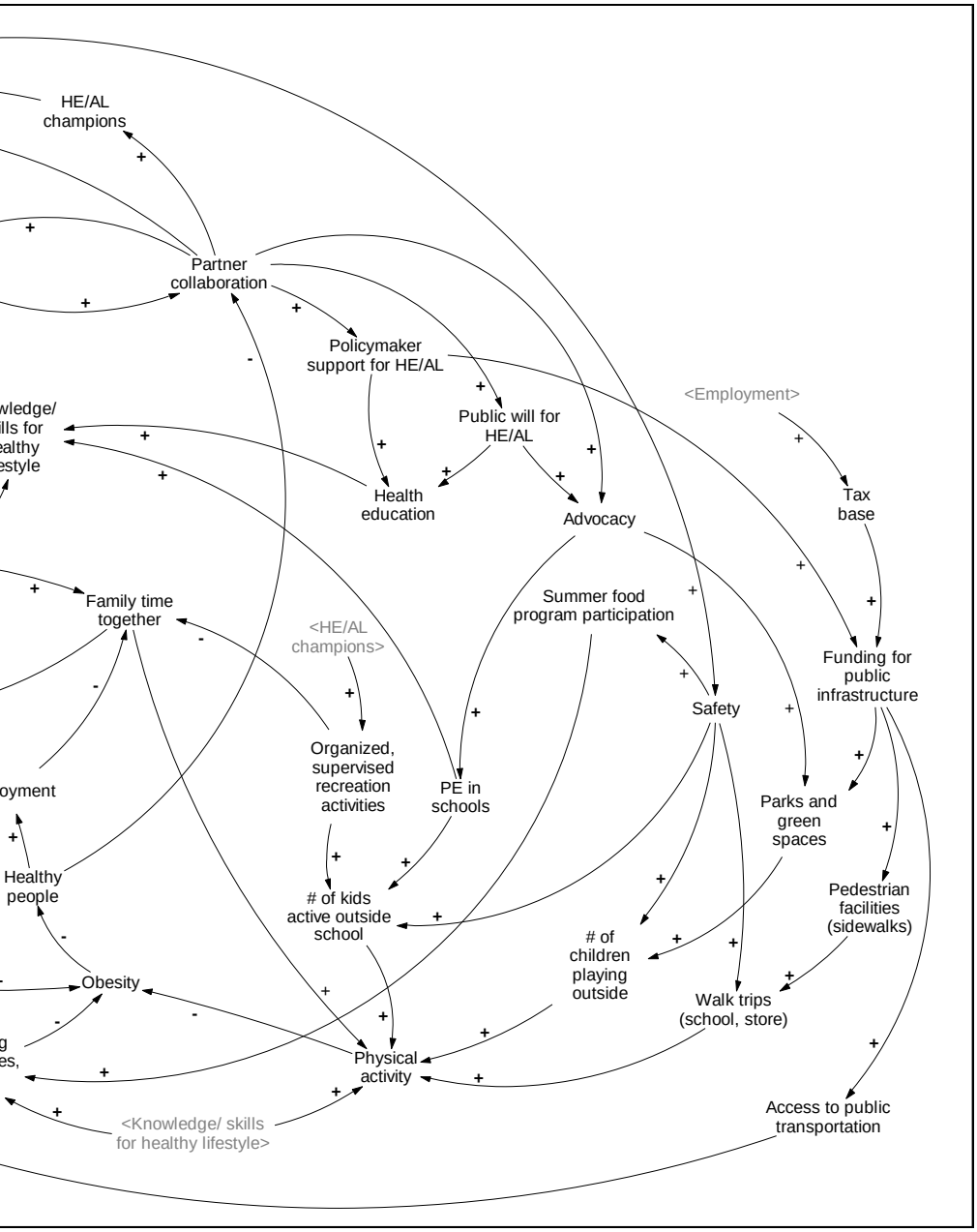
- the participants represent a sample of the *KEYS 4 HealthyKids* partners (organizations and residents) as opposed to a representative snapshot of government agencies, community organizations, businesses, and community residents;
- the behavior over time graphs and the causal loop diagram represent perceptions of the participants in these exercises (similar to a survey or an interview representing perceptions of the respondents);
- the exercises and associated dialogue took place in brief one- to two-hour sessions, compromising the group's capacity to spend too much time on any one variable, relationship, or feedback loop; and
- the responses represent a moment in time so the underlying structure of the diagram and the types of feedback represented may reflect "hot button" issues of the time.

Much work is yet to be done to ensure that this causal loop diagram is accurate and comprehensive, for example:

- having conversations to discuss existing feedback loops to ensure that the appropriate variables and

relationships are represented accurately;

- reviewing the behavior over time graphs (see also Appendix E) to confirm that the trends reflect common perceptions among residents and compare these trends to actual data;
- revisiting variables removed because they were not part of feedback loops, including car dependence, knowledge of food production, health insurance, advertising, food storage and cooking facilities, healthy vending and concession stands, changes in HE/AL guidelines, community/faith-based organization recreation facilities, crime, screen time, access to child care, funding for food assistance, funding for schools, breastfeeding, healthy schools act (policy), academic curriculum, suburban sprawl, sugar sweetened beverages in child care, school staff, school recreation facilities, school programs for healthy lifestyles, gas prices, liability for food safety, community kitchens/food pantries/ senior centers, time for meal preparation, water consumption, zoning regulations for HE/AL, government subsidized agriculture, unhealthy food/beverage taxes portion control policies, educational attainment; and



- starting new conversations about other variables (behavior over time graphs exercise) or relationships (causal loop diagram exercise) to add to this diagram.

In addition, different subgroups in Charleston may use this causal loop diagram to delve in deeper into some of the subsectors (e.g., healthy eating, active living) or feedback loops, creating new, more focused causal loop diagrams with more specific variables and causal relationships.

Use of more advanced systems science methods and analytic approaches to create computer simulation models is another way to take this early work to the next level. The references section includes citations for resources on these methods and analytic approaches, and it is necessary to engage professional systems scientists in these activities.

Please refer to the Appendices for more information, including:

- Appendix A: Behavior over time graphs generated during site visit
- Appendix B: Photograph of the original version of the *KEYS 4 HealthyKids* Causal Loop Diagram
- Appendix C: Original translation of the causal loop diagram into Vensim PLE
- Appendix D: Transcript translation of the causal loop diagram into Vensim PLE
- Appendix E: Behavior over time graphs not represented in the storybook

References for Systems Thinking in Communities:

Group model building handbook:
Hovmand, P., Brennan L., & Kemner, A. (2013). Healthy Kids, Healthy Communities Group Model Building Facilitation Handbook. Retrieved from http://www.transtria.com/hkhc.

Vensim PLE software for causal loop diagram creation and modification:
Ventana Systems. (2010). Vensim Personal Learning Edition (Version 5.11A) [Software]. Available from http://vensim.com/vensim-personal-learning-edition/

System dynamics modeling resources and support:
Andersen, D. F. and G. P. Richardson (1997). "Scripts for group model building." System Dynamics Review 13(2): 107-129.

Hovmand, P. (2013). Community Based System Dynamics. New York, NY: Springer.

Hovmand, P. S., et al. (2012). "Group model building "scripts" as a collaborative tool." Systems Research and Behavioral Science 29: 179-193.

Institute of Medicine (2012). An integrated framework for assessing the value of community-based prevention. Washington, DC, The National Academies Press.

Meadows, D. (1999). Leverage points: places to intervene in a system. Retrieved from http://www.donellameadows.org/archives/leverage-points-places-to-intervene-in-a-system/

Richardson, G. P. (2011). "Reflections on the foundations of system dynamics." System Dynamics Review 27 (3): 219-243.

Rouwette, E., et al. (2006). "Group model building effectiveness: A review of assessment studies." System Dynamics Review 18(1): 5-45.

Sterman, J. D. (2000). Business dynamics: Systems thinking and modeling for a complex world. New York, NY: Irwin McGraw-Hill.

System Dynamics in Education Project. (1994). Road maps: A guide to learning system dynamics. Retrieved from http://www.clexchange.org/curriculum/roadmaps/

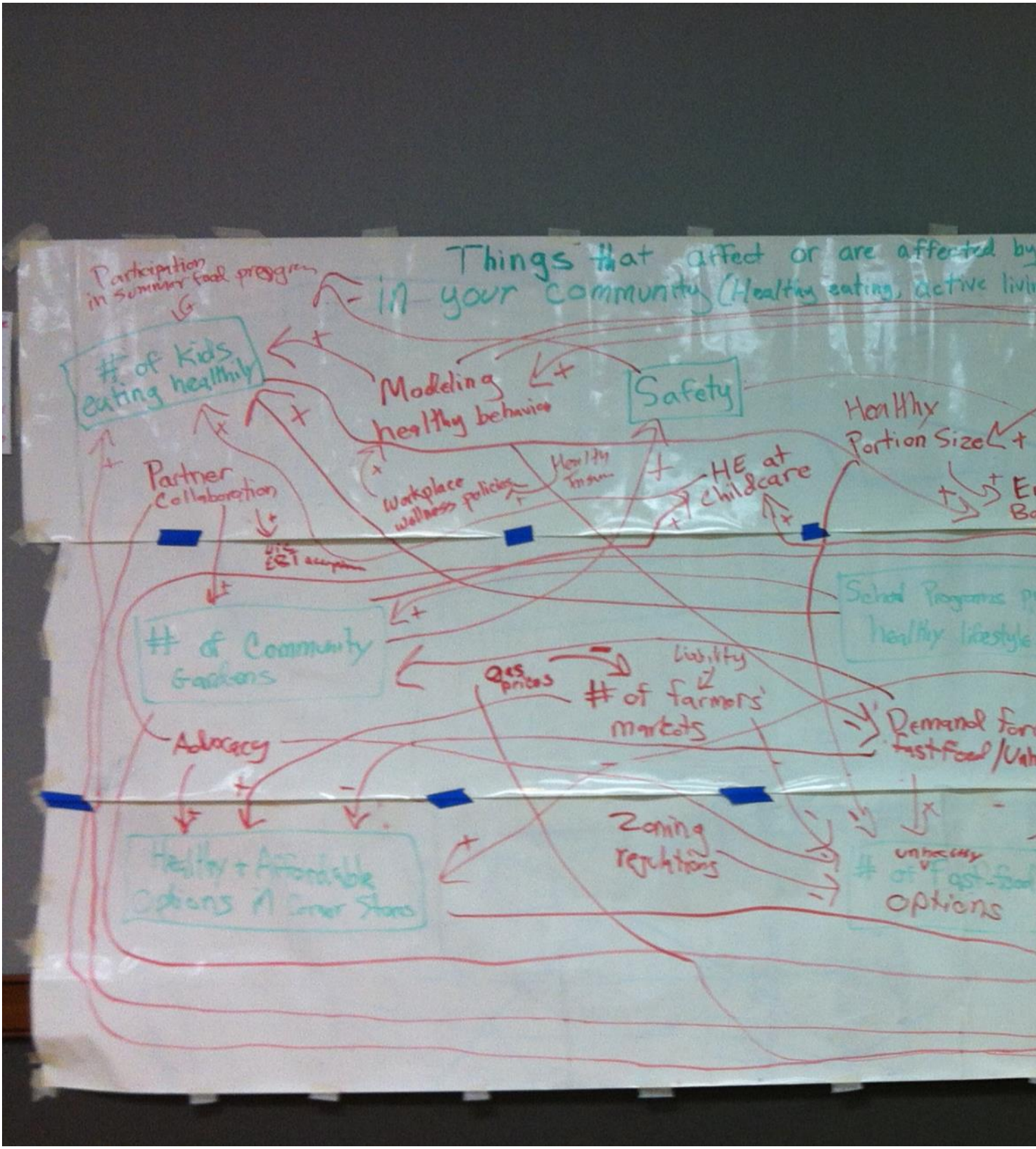
Vennix, J. (1996). Group model building. New York, John Wiley & Sons.

Zagonel, A. and J. Rohrbaugh (2008). Using group model building to inform public policy making and implementation. Complex Decision Making. H. Qudart-Ullah, J. M. Spector and P. I. Davidsen, Springer-Verlag: 113-138.

Appendix A: Behavior Over Time Graphs Generated during Site Visit

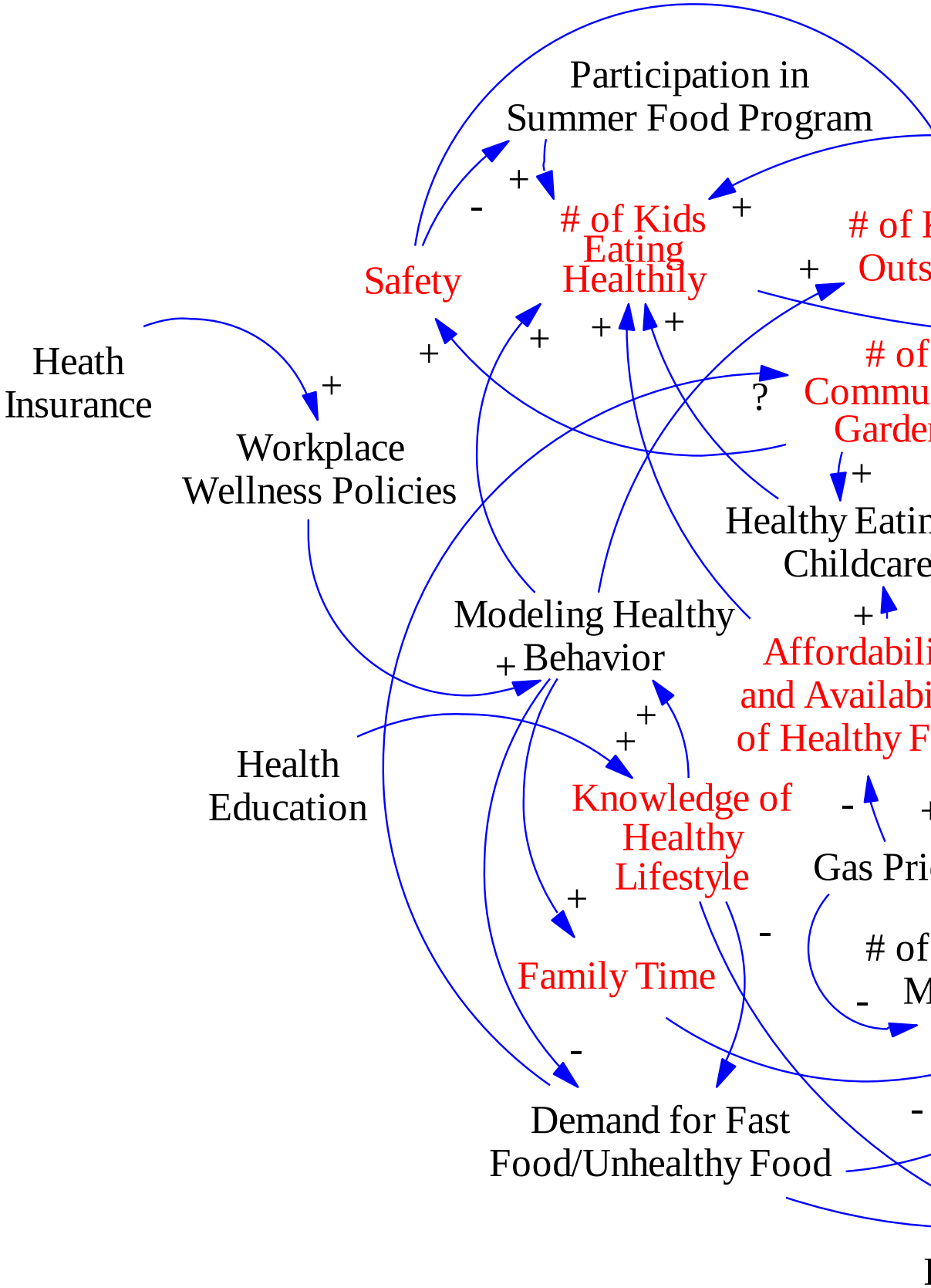
Charleston, West Virginia: *KEYS 4 HealthyKids*	
Categories	**Number of Graphs**
Active Living Behavior	7
Active Living Environments	1
Funding	2
Healthy Eating Behavior	4
Healthy Eating Environments	19
Marketing and Media Coverage	1
Obesity and Long Term Outcomes	0
Partnership & Community Capacity	1
Policies	2
Programs & Promotions (Education and Awareness)	5
Social Determinants of Health	2
Total Graphs	**44**

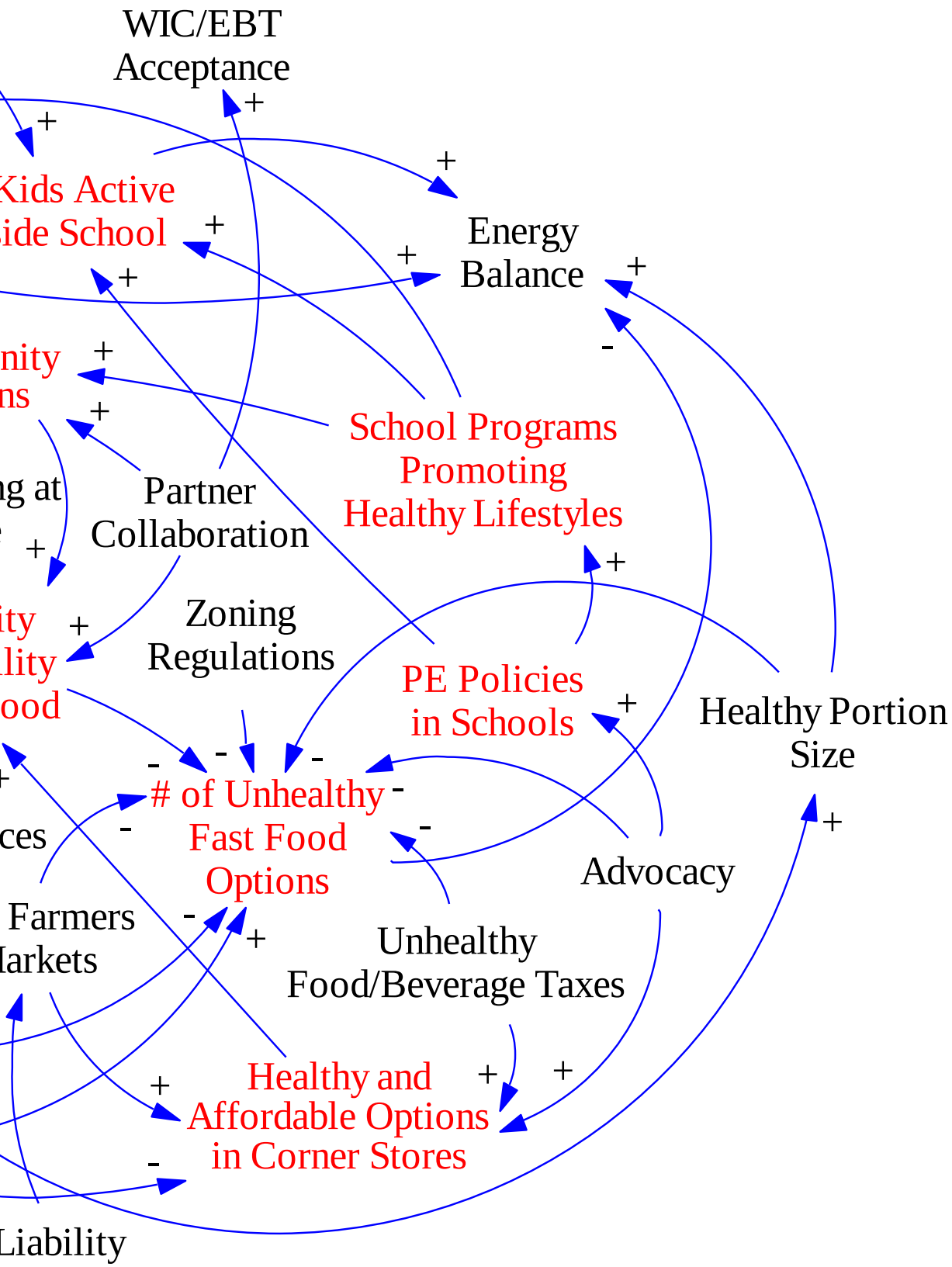
Appendix B: Photograph of the Original Version of the *KEYS 4 HealthyKids* Causal Loop Diagram



⊕ ↑↑ OR ↓↓
⊖ ↑↓ OR ↓↑
policy, system, or environmental Changes
and Childhood
Knowledge of Healthy Lifestyle
P.E. policies in Schools
Individual Choices
Health Education
Family Time
# of kids active outside school
Unhealthy Food/Beverage Taxes

Appendix C: Original Translation of the Causal Loop Diagram into Vensim PLE




WIC/EBT
Acceptance
Kids Active
ide School
Energy
Balance
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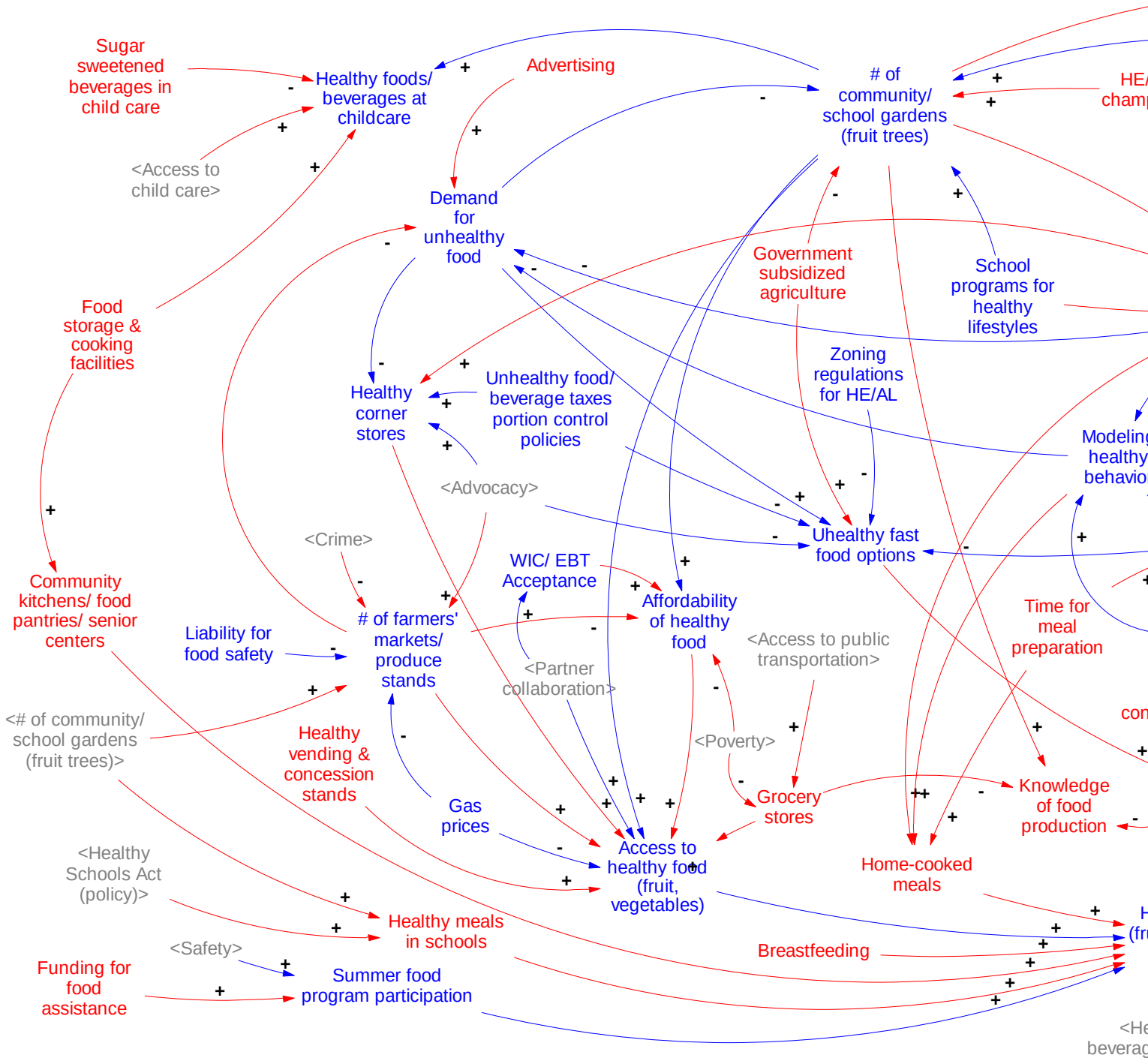
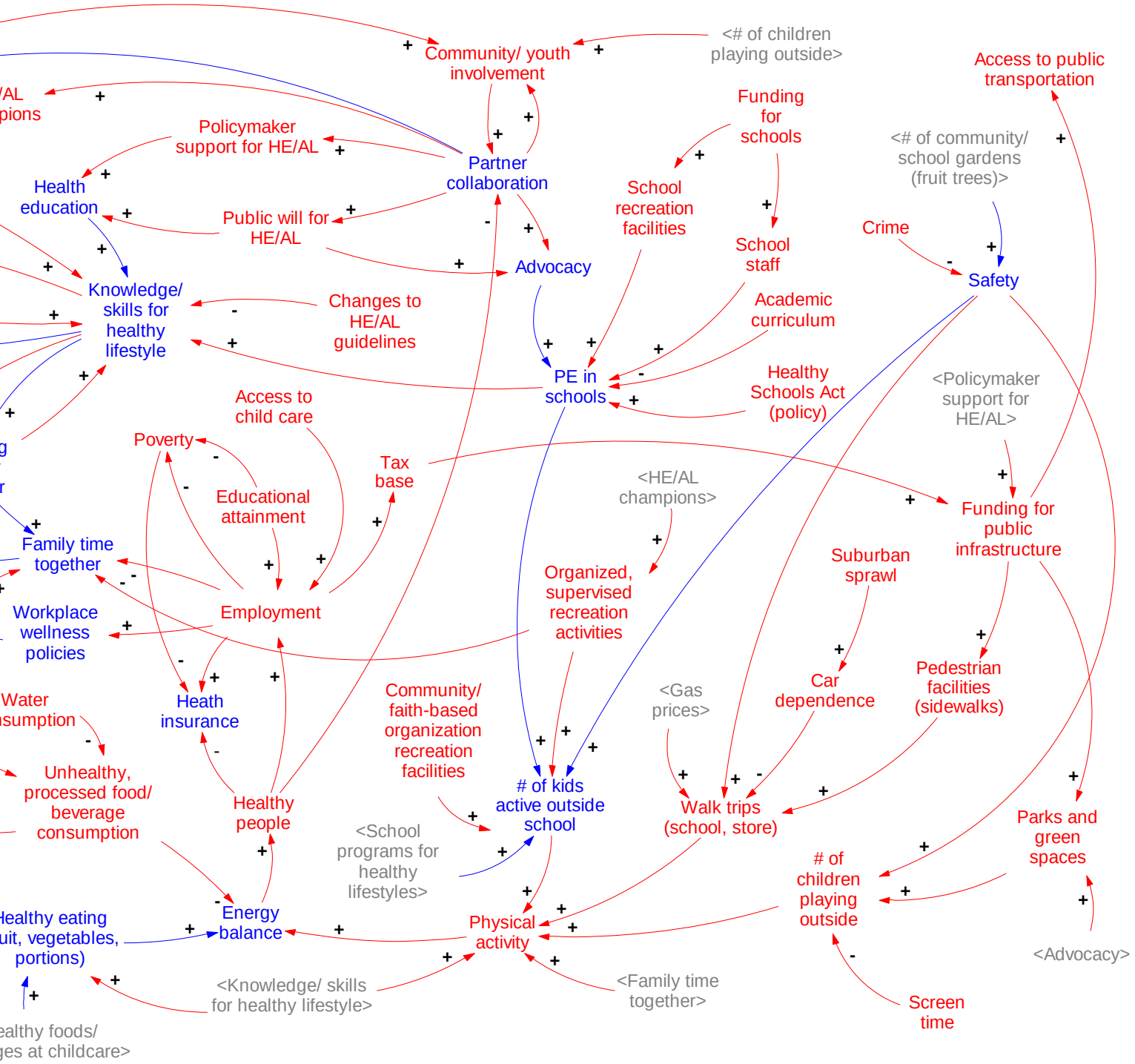
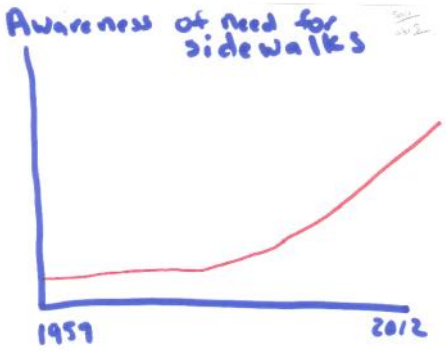
School Programs
Promoting
Healthy Lifestyles
g at
Partner
Collaboration
ity
lity
ood
Zoning
Regulations
PE Policies
in Schools
Healthy Portion
Size
# of Unhealthy
Fast Food
Options
ces
Advocacy
Farmers
larkets
Unhealthy
Food/Beverage Taxes
Healthy and
Affordable Options
in Corner Stores
Liability

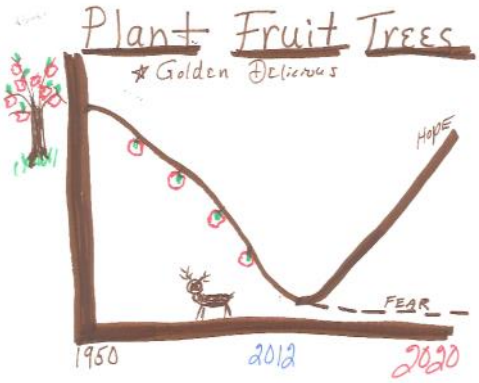
Appendix D: Transcript Translation of the Causal Loop Diagram into Vensim PLE

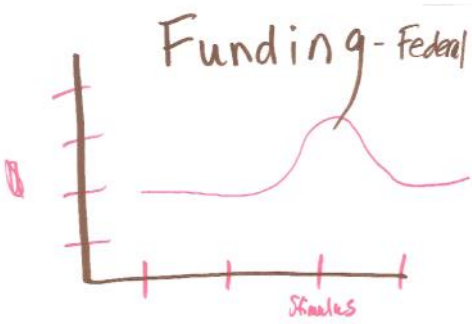


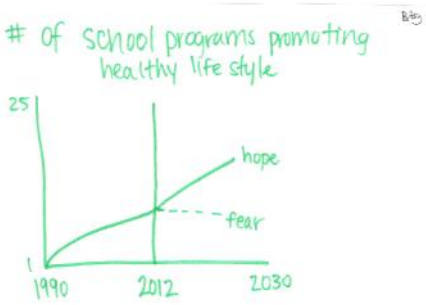

Community/ youth involvement
<# of children playing outside>
Access to public transportation
/AL pions
Policymaker support for HE/AL
Partner collaboration
Funding for schools
<# of community/ school gardens (fruit trees)>
Health education
Public will for HE/AL
School recreation facilities
School staff
Crime
Advocacy
Safety
Knowledge/ skills for healthy lifestyle
Changes to HE/AL guidelines
Academic curriculum
PE in schools
Healthy Schools Act (policy)
<Policymaker support for HE/AL>
Access to child care
Poverty
Tax base
Educational attainment
<HE/AL champions>
Funding for public infrastructure
Family time together
Suburban sprawl
Organized, supervised recreation activities
Workplace wellness policies
Employment
Car dependence
Pedestrian facilities (sidewalks)
Water nsumption
Heath insurance
Community/ faith-based organization recreation facilities
<Gas prices>
Unhealthy, processed food/ beverage consumption
Healthy people
# of kids active outside school
Walk trips (school, store)
Parks and green spaces
<School programs for healthy lifestyles>
# of children playing outside
Healthy eating uit, vegetables, portions)
Energy balance
Physical activity
<Advocacy>
<Knowledge/ skills for healthy lifestyle>
<Family time together>
Screen time
ealthy foods/ ges at childcare>

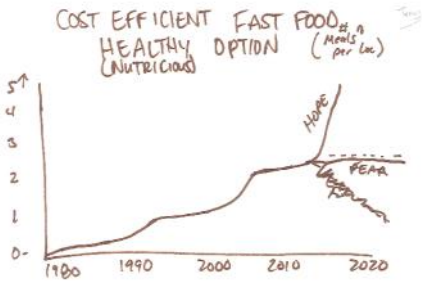
Appendix E: Behavior Over Time Graphs not Represented in the Storybook

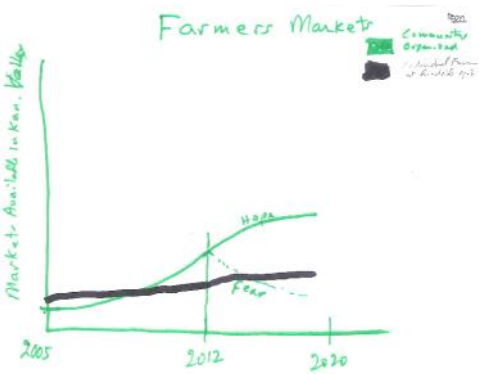


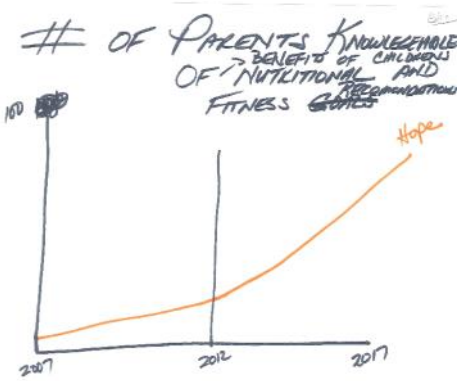


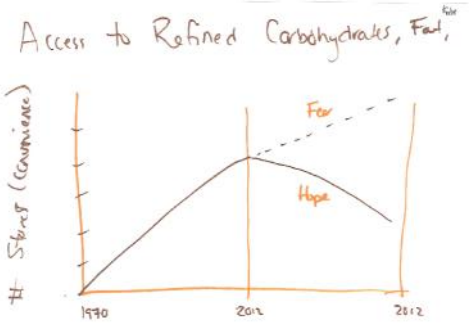


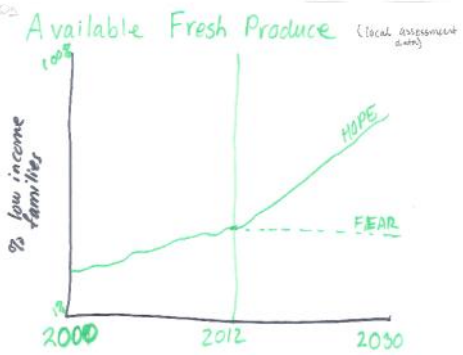


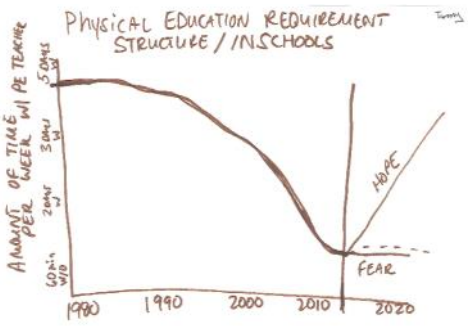


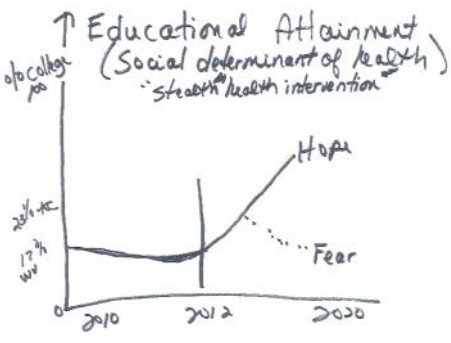


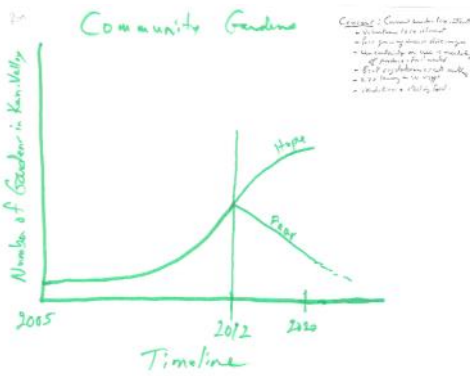


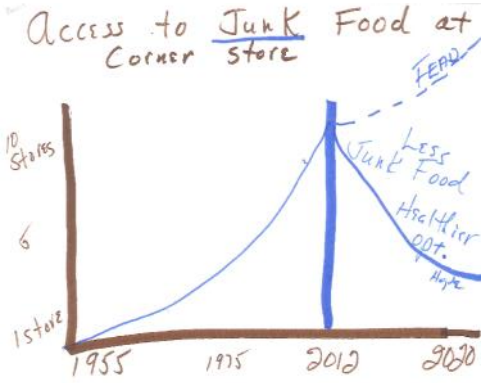


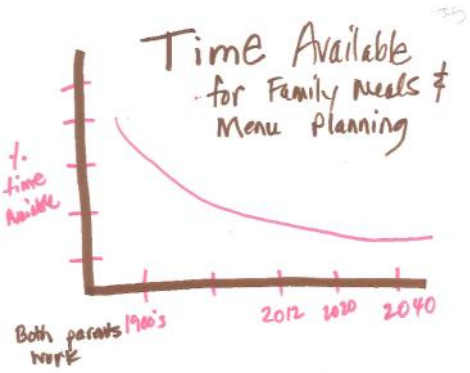




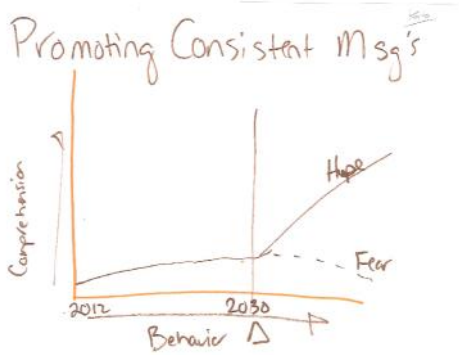


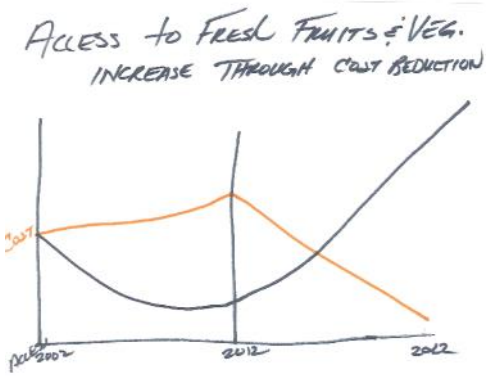


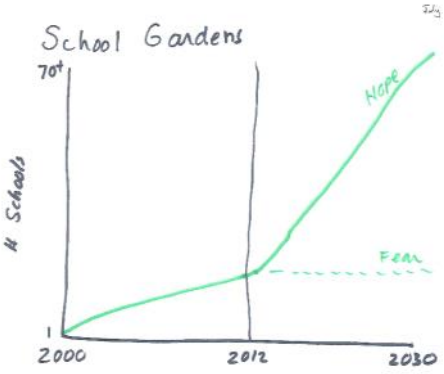

Access to Junk Food at Corner Store
FEAR
10 Stores
6
1 Store
Less Junk Food
Hope
1955
1975
2012
2020

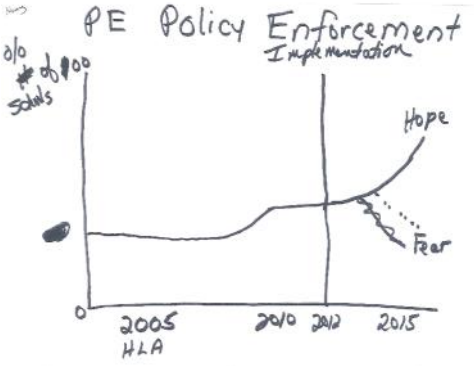

Time Available for Family Meals & Menu Planning
↓ time Available
Both parents work
1960's
2012
2020
2040

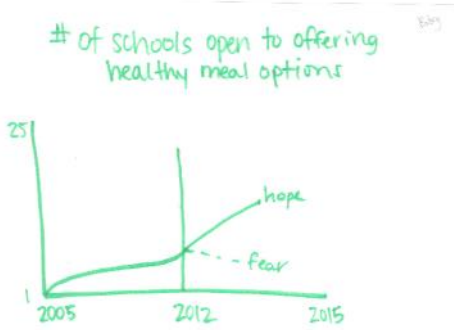
Availability of Community Garden
High
Low
HOPE
FEAR
1980
2012
2020


Promoting Consistent Msg's
Comprehension
Hope
Fear
2012
2030
Behavior Δ

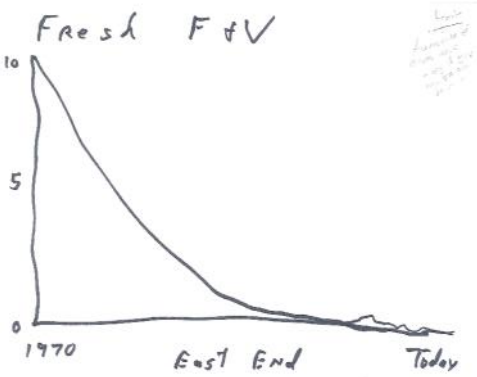

Access to Fresh Fruits & Veg.
INCREASE THROUGH COST REDUCTION
Cost
past 2002
2012
2042

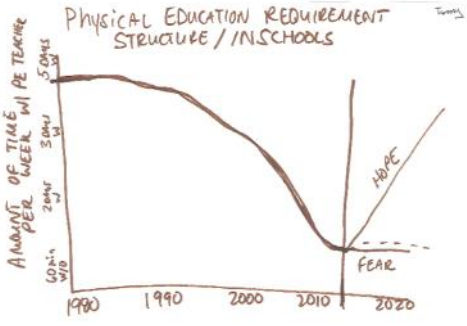

School Gardens
70+
Schools
1
HOPE
FEAR
2000
2012
2030

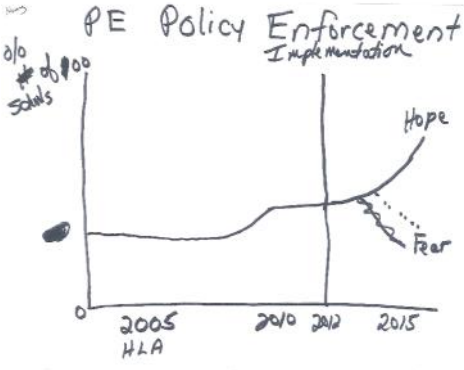
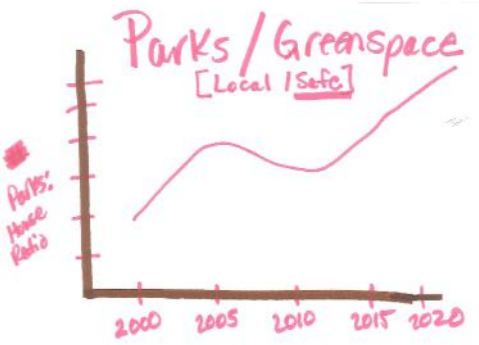
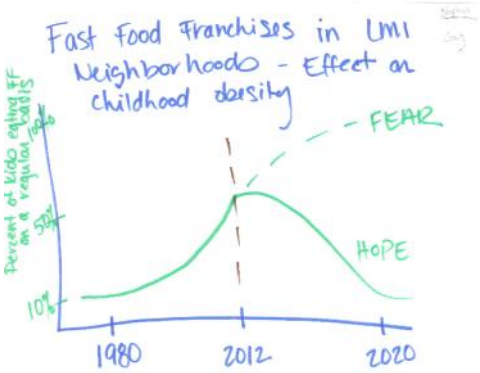
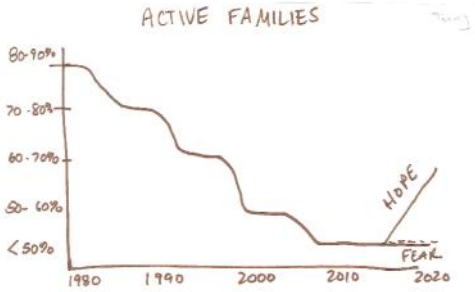
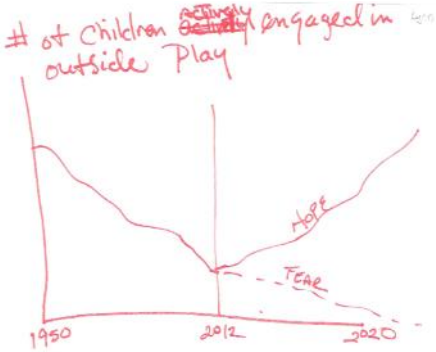
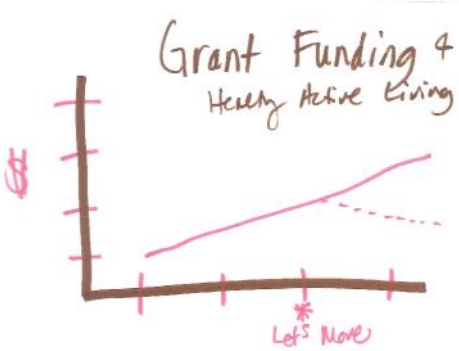
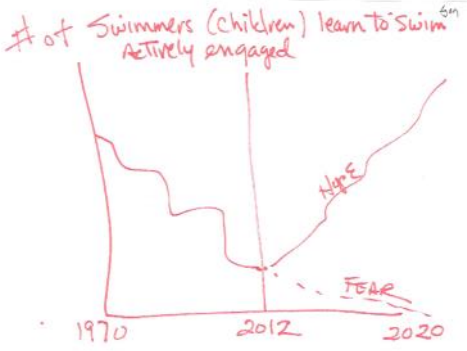
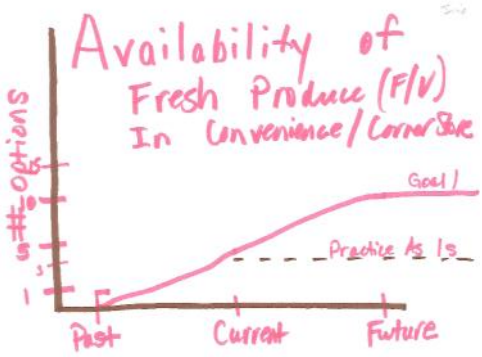
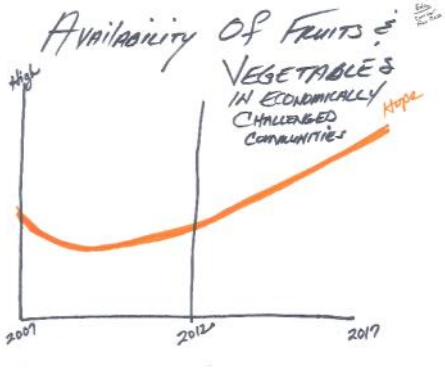
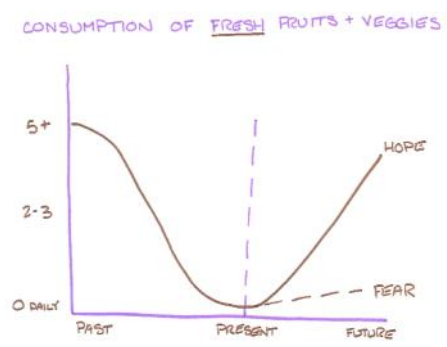

PE Policy Enforcement
Implementation
d/o # of 100 Schools
Hope
Fear
0
2005 HLA
2010
2012
2015


# of schools open to offering healthy meal options
25
1
hope
fear
2005
2012
2015

School Gardens
gardens
12
10
8
6
4
2
2008
2010
2012
2014
2016


Fresh F&V
10
5
0
1970
East End
Today


Physical Education Requirement
Structure / In Schools
Amount of time per week w/ PE teacher
5 days w/
3 days w/
2 days w/
0 days w/o
HOPE
FEAR
1980
1990
2000
2010
2020


PE Policy Enforcement
Implementation
d/o # of 100 Schools
Hope
Fear
0
2005 HLA
2010
2012
2015

Appendix E (continued): Behavior Over Time Graphs not Represented in the Storybook