Systems Thinking in Communities:

Understanding the Causes of Inactivity, Poor Diet/Nutrition, and Childhood Obesity in Knox County, Tennessee

This community storybook was developed by Transtria LLC.

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Introduction

Knox County Healthy Kids, Healthy Communities 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 *Knox County Healthy Kids, Healthy Communities* project was to introduce systems thinking at the community level by identifying the essential parts of the Knox County 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 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., community-based organizations, government agencies, academic institutions, advocacy agencies, youth organizations, businesses) 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.

Knox County, Tennessee : Background and Local Participation

Situated in the foothills of the Great Smoky Mountains, Knox County is the largest county in East Tennessee, with a population of 432,226. Residents are 85.6% white, 8.8% black, and 5.6% identified as other races (e.g., Asian, American Indian, some other race). Approximately 14% of individuals live below the poverty level, and the median household income is $47,270. About 22% of the population is children 18 years of age and younger. The target area consists of three communities: Lonsdale, Inskip, and Mascot. Lonsdale is a urban community located in the central Knoxville. Inskip is a suburban neighborhood located in north Knoxville. Mascot, a rural community, is located about 14 miles from downtown Knoxville. According to the Knoxville-Knox County Metropolitan Planning Commission, Lonsdale has the lowest median household income ($25,128) in Knox County.

Knox County Health Department was the lead agency for the Knox County Healthy Kids, Healthy Communities partnership. The department provided services in three areas, including clinical health (e.g., adult primary care, immunizations) environmental health (e.g., vector control, food protection), and healthy living (e.g., tobacco prevention, Eat Play Live Knoxville, Together Healthy Knox). Prior to receiving HKHC funds, a partnership was established to work with the Safe Routes to School Coalition and the Food Policy Council. Then a Steering Committee was developed by the Knox County Health Department to advise the HKHC initiative. The committee was comprised of local partners that were recruited for their level of expertise in healthy eating and active living policy and environment change. Three Community Action Teams were formed by community leaders and advocates with support from the HKHC Project Director, Project Manager, and Program Coordinator to represent Lonsdale, Inskip, and Mascot.

Knox County Healthy Kids, Healthy Communities' Priorities and Strategies

The partnership and capacity building strategies of *Knox County Healthy Kids, Healthy Communities* included:

- **Community Action Teams:** Three Community Action Teams were formed by community leaders with the support of HKHC staff to address healthy eating and active living priorities and lead change efforts in Lonsdale, Inskip, and Mascot.
- **Knoxville-Knox County Food Policy Council:** The partnership supported the revitalization of the Knoxville-Knox County Food Policy Council. In 2013, the council released policy recommendations, reports, and resources focused on healthy eating.

The healthy eating and active living strategies of *Knox County Healthy Kids, Healthy Communities* included:

- **Action Transportation:** To increase walkability and bikeability in Lonsdale, Inskip, and Mascot, the HKHC partnership worked to implement infrastructure changes, such as crosswalks, sidewalks, traffic calming murals, and pedestrian way finding signs.
- **Parks and Recreation:** The partnership collaborated with actions teams and community members in Lonsdale and Mascot to increase access to physical activity opportunities by refurbishing a playground and adding sports equipment (e.g., basketball goals).
- **Access to Healthy Foods:** The partnership in collaboration with the Food Policy Council worked to limit barriers to healthy food options and to encourage more local food system options across Knox County.

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

Systems Thinking in Communities: Knox County, Tennessee

"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 Knox County, Tennessee 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.

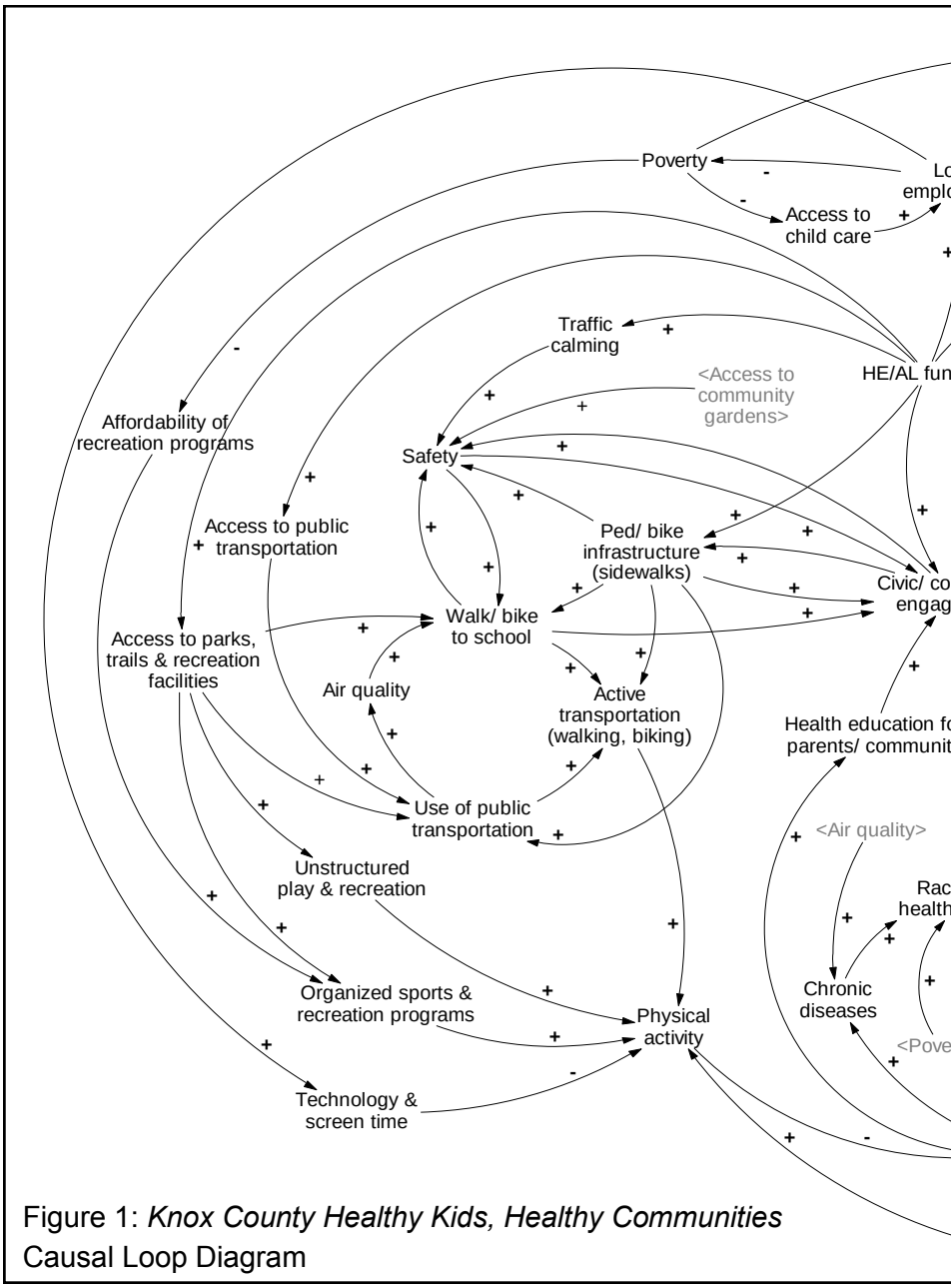


Figure 1: *Knox County Healthy Kids, Healthy Communities* Causal Loop Diagram

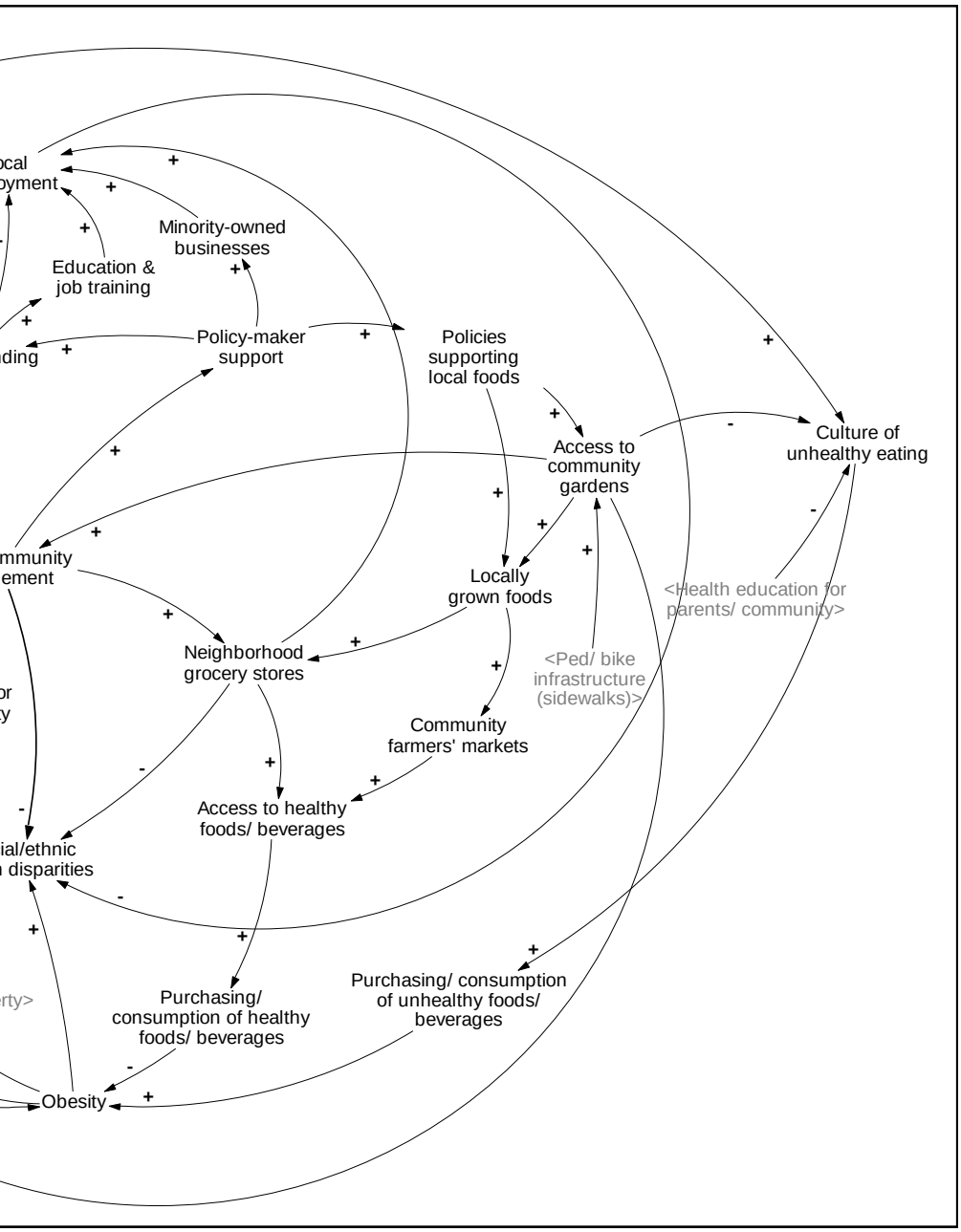
Group Model Building

Members of the *Knox County Healthy Kids, Healthy Communities* partnership participated in a group model building session in May, 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 community-based organizations, government agencies, academic institutions, advocacy agencies, youth organizations, and businesses. 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.

Behavior Over Time Graphs

To identify the range of things that affect or are affected by policy, system, and environmental changes in Knox County 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, the stress levels in kids has increased since 1970 to 2012 due to all the pressure on kids to be healthy and successful. Participants described the hope that stress levels in kids will change and decrease into the future (see behavior over time graph 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 civic and community engagement in this causal loop diagram. One feedback loop is: civic and community engagement → pedestrian and bike infrastructure → walk and bike to school → civic and community engagement. A second feedback loop is: civic and community engagement → policy-maker support → healthy eating and active living funding → civic and community engagement.

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 civic and community engagement. Some variables may increase civic and community engagement while other variables limit civic and community engagement. 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 *Knox County Healthy Kids, Healthy Communities* 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 Knox County, Tennessee and to stimulate greater conversation related to Knox County '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 Knox County, Tennessee. 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.

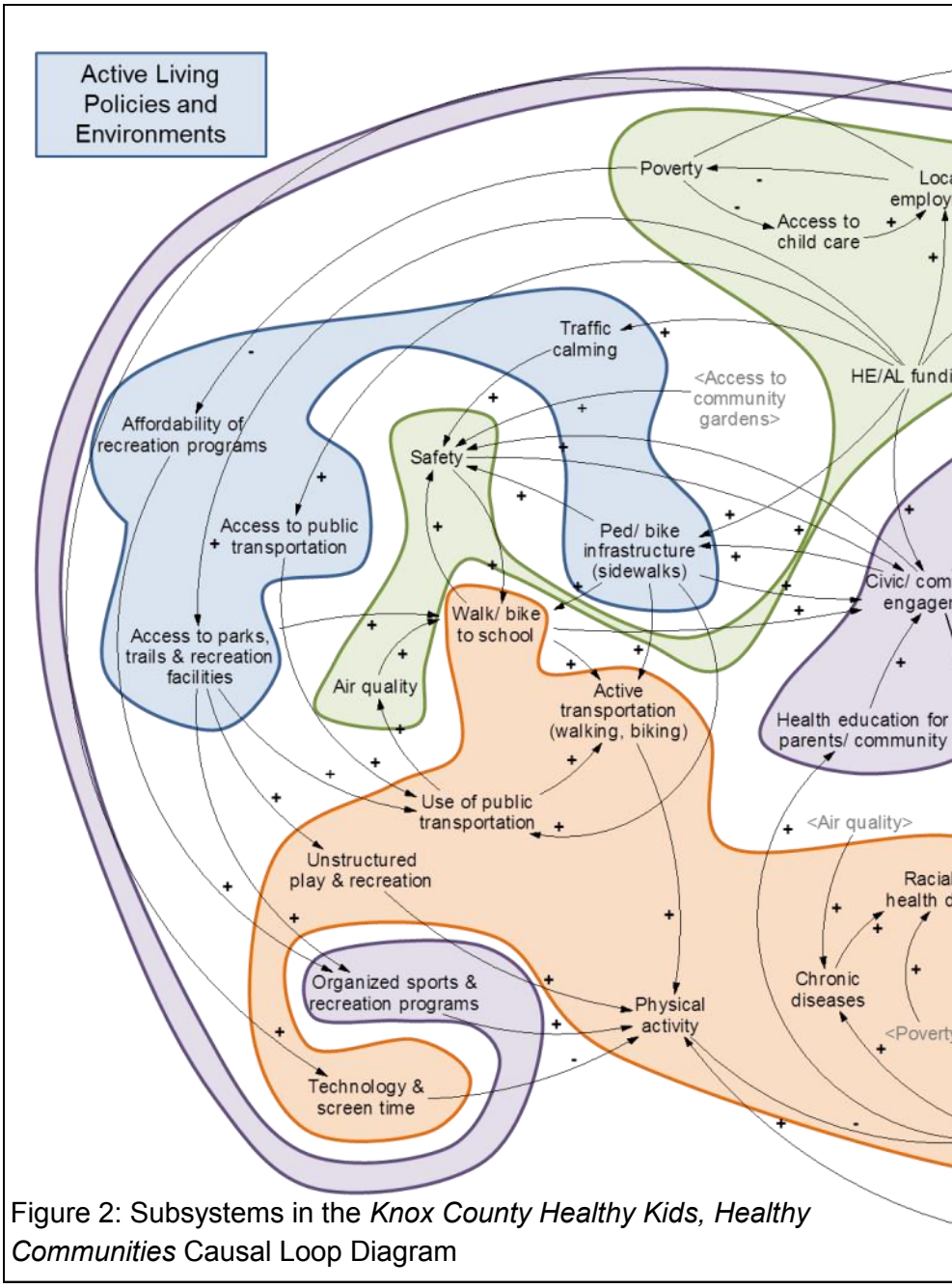


Figure 2: Subsystems in the *Knox County Healthy Kids, Healthy Communities* Causal Loop Diagram

Healthy Eating Policies and Environments (Red)

The healthy eating policy and environmental subsystem includes food production (e.g., locally grown foods), food distribution and procurement (e.g., access to community gardens), and food retail (e.g., neighborhood grocery stores). During the behavior over time graphs exercise, the participants generated seven graphs related to policy or environmental strategies (e.g., community farmers' markets) or contexts (e.g., locally grown foods) that affected or were affected by the work of *Knox County Healthy Kids, Healthy Communities*. The variables represent participants' conversations from the behavior over time graph and causal loop diagram exercises.

Active Living Policies and Environments (Blue)

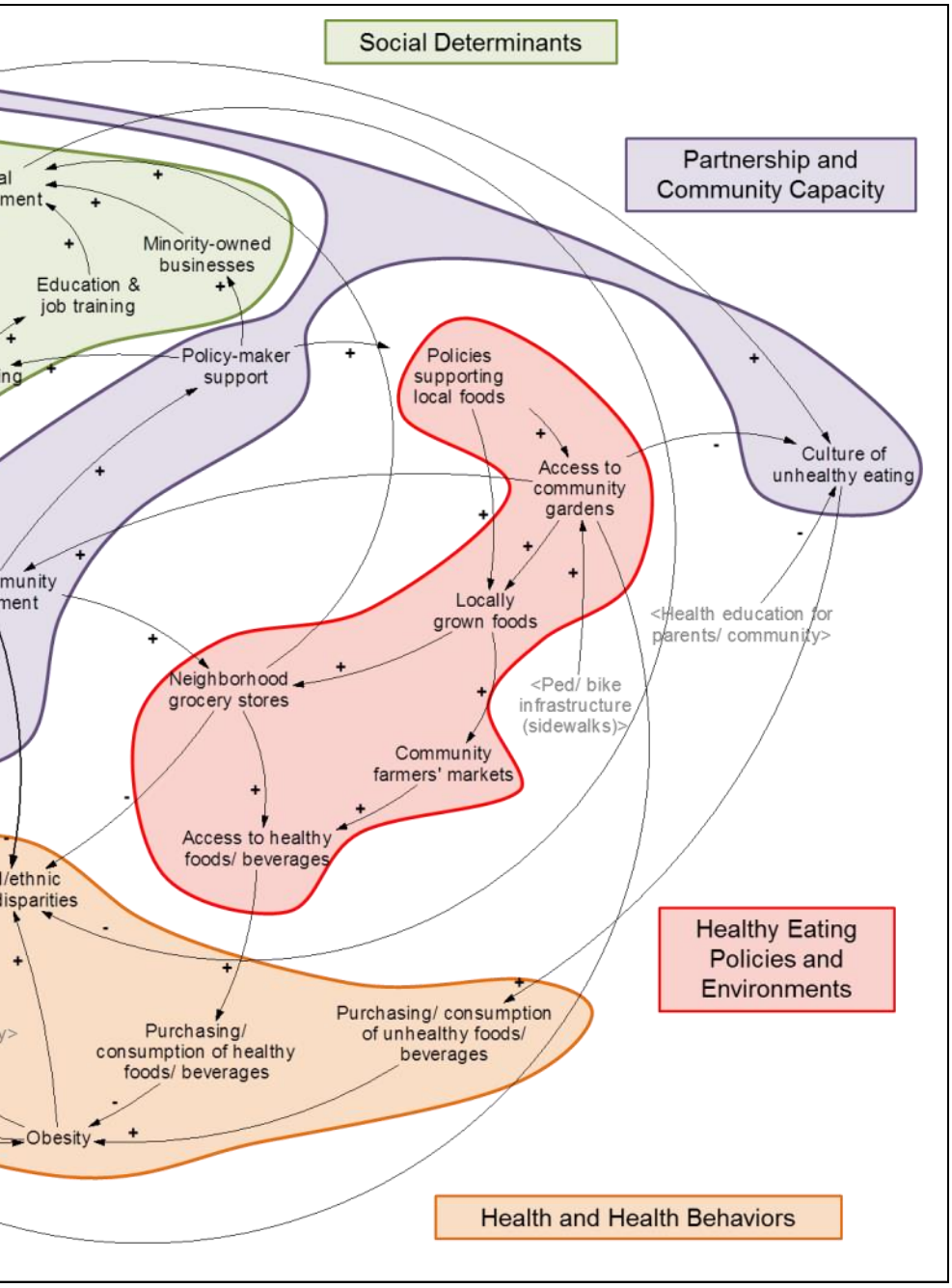
The active living policy and environmental subsystem includes design, planning, construction, and enforcement or maintenance related to access to opportunities for active transportation and recreation. For this topic, the group model building participants developed 13 graphs related to policy or environmental strategies (e.g., traffic calming, pedestrian and bike infrastructure) or contexts (e.g., affordability of recreation programs) that affected or were affected by the partnership's work.

Health and Health Behaviors (Orange)

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., use of public transportation, purchasing and consumption of healthy foods and beverages).

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, *Knox County Healthy Kids, Healthy Communities* partnership supported the revitalization of the Knoxville-Knox County Food Policy Council, which engaged city leaders, residents, and a variety partners (e.g., farmers, businesses, health organizations).



This subsystem also includes community factors outside the partnership that may influence or be influenced by their efforts, such as health education for parents and community and organized sports and recreation programs.

Social Determinants

Finally, the social determinants subsystem denotes societal conditions (e.g., local employment, access to child care, healthy eating and active living funding) and psychosocial influences (e.g., safety, racial and ethnic health disparities) 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 *Knox County Healthy Kids, Healthy Communities* partners or by other representatives in Knox County, Tennessee. 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 civic and community engagement, pedestrian and bike infrastructure, and health education for parents and community.

The next sections begin to examine the feedback loops central to the work of *Knox County Healthy Kids, Healthy Communities*. 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.

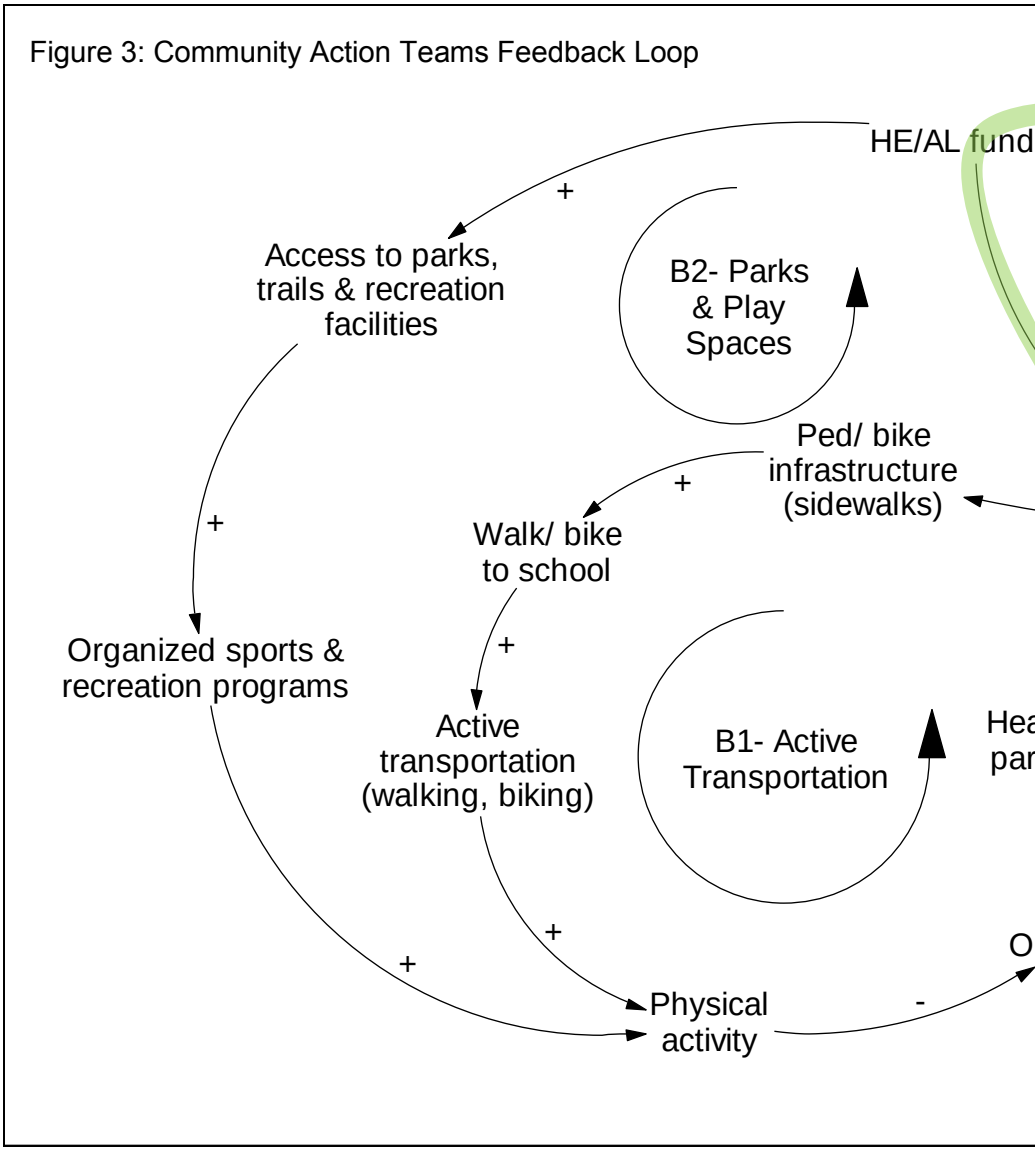
Community Action Teams Feedback Loop

To simplify the discussion about feedback loops, several loops drawn from the Knox County Healthy Kids, Healthy Communities CLD (see Figures 1 and 2) are highlighted in Figures 3-6. While the CLD provides a theory of change for the childhood obesity prevention movement in Knox County, Tennessee, 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 Community Action Teams (green highlighted loop in Figure 3) designed to support the healthy eating and active living priority areas. Participants described how more civic and community engagement through the Action Teams increased the support from policy makers. As there was more support from policy makers, there was also an increase in healthy eating and active living funding for the priority areas. In turn, more healthy eating and active living funding increased the ongoing support and civic and community engagement in Knox County.

Figure 3: Community Action Teams Feedback Loop



Story B: While the preceding story reflected a positive scenario for Knox County, Tennessee , the same feedback loop also tells the opposite story. With less civic and community engagement and participation in the Action Teams, there is a decrease in the support from policy makers. As there was less support from policy makers, there was also a decrease in healthy eating and active living funding for the priority areas. In turn, less healthy eating and active living funding decreased the ongoing support and civic and community engagement in Knox County.

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 — Community Action Teams" 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

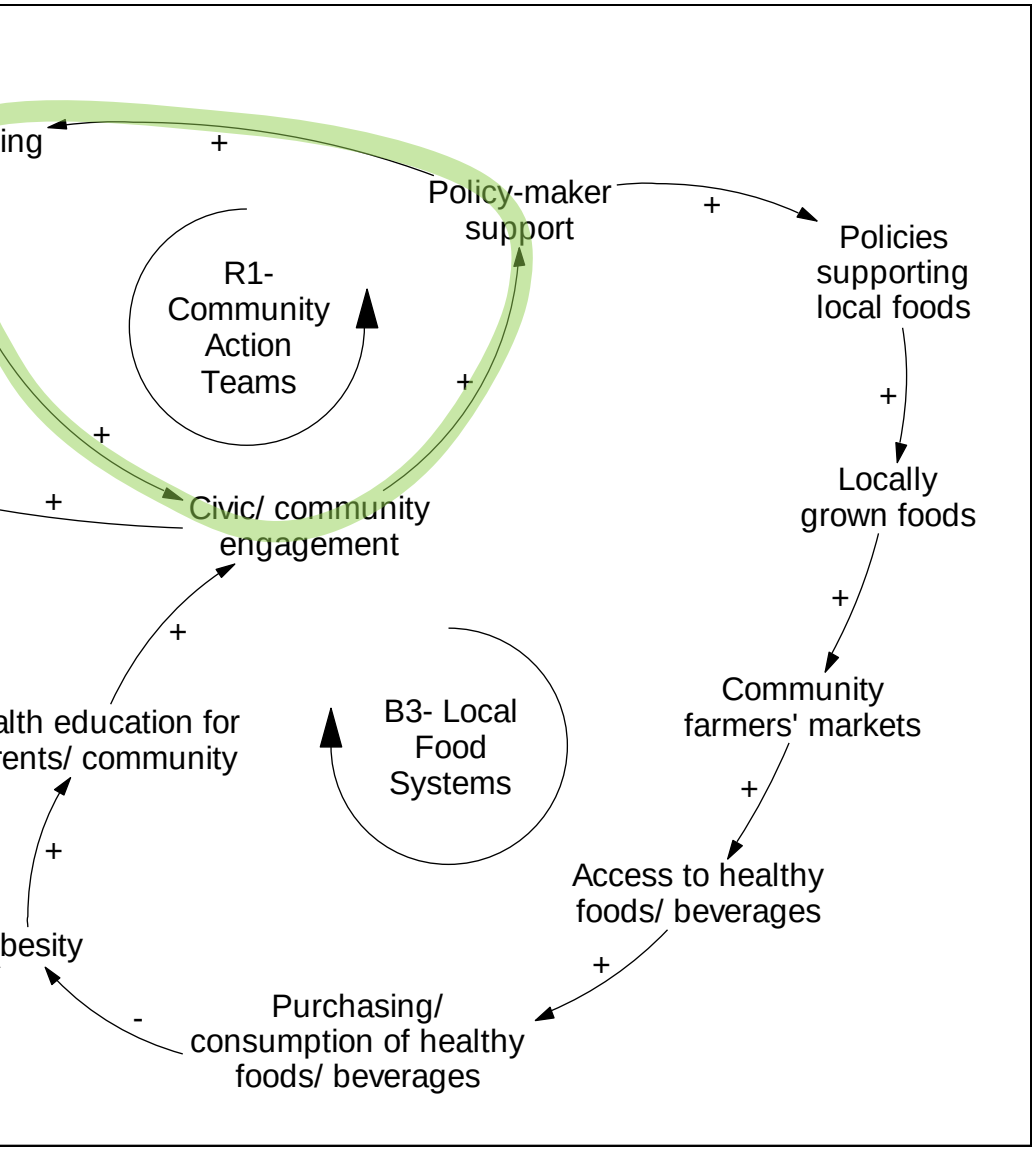
"My perception is that when neighborhoods and communities participate civically, have a voice in government, and feel that they have a high amount of social capital, they tend to get the things that their neighborhoods, families, and children need in order to be healthy. [When civic engagement stops], people tend to have those resources taken away from them without being able to stop it." (Participant)

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). 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 civic and community engagement likely levels off at some point. To understand what specifically leads to the leveling off of civic and community engagement, it may be helpful for the partners in Knox County, Tennessee to consider other variables that influence or are influenced by civic and community engagement. 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.

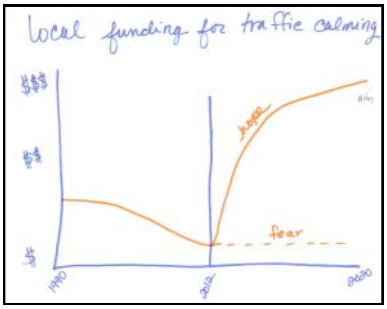


<u>System Insights for *Knox County Healthy Kids, Healthy Communities*</u>

Participants identified a decrease in the local funding for traffic calming and other healthy eating and active living initiatives since 1990 to 2012 with the hope that local funding will increase into the future (see behavior over time graph on the bottom right).

From the systems thinking exercises, several insights can inform the community action teams strategy, including:

- Strategic partnerships to engage residents in advocacy initiatives stimulate support and funding from city government agencies.
- 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).
- New collaborations forged with city agency representatives or community organization leaders generates more political will in various sectors of the community for those whose voices are not well represented.



Active Transportation Feedback Loop

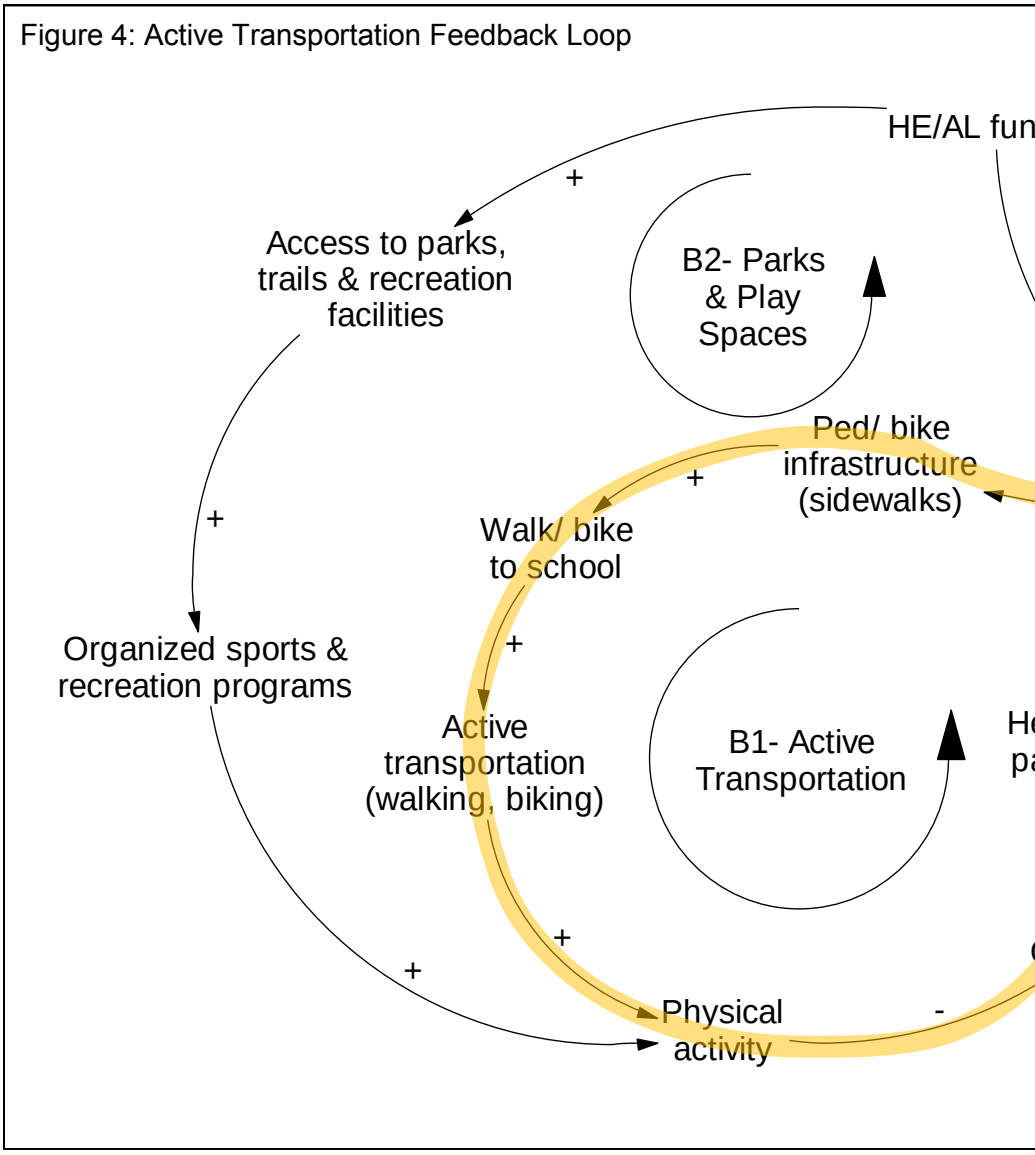
Given the introduction to feedback loops and CLD notation in the previous section, this discussion of the feedback loop highlighted in orange in Figure 4 expands on the concepts and notation, and highlights active transportation.

Causal Story for Feedback Loop

Story A: Participants described with an increase in the pedestrian and bike infrastructure, there is an increase in the number of youth walking and biking to school. With more individuals utilizing active transportation through walking and biking, there is an increase in the amount of physical activity for residents, which decreases obesity. As obesity rates are decreasing, there is also a decrease in the need for health education for parents and the community as obesity is becoming less of a problem. With less health education, there is less civic and community engagement around obesity issues, which decreases the focus for pedestrian and bike infrastructure.

Story B: Alternatively, with a decrease in the pedestrian and bike infrastructure, there is a decrease in the number of youth walking and biking to school. With less individuals utilizing active transportation through walking and biking, there is a decrease in the amount of physical activity for residents, which increases obesity. As obesity rates are increasing, there is also an increase in the need for health education for parents and the community as obesity is becoming more of a problem. With more health education, there is more civic and community engagement around obesity issues, which increases the focus for pedestrian and bike infrastructure.

Figure 4: Active Transportation Feedback Loop



Balancing Loop and Notation

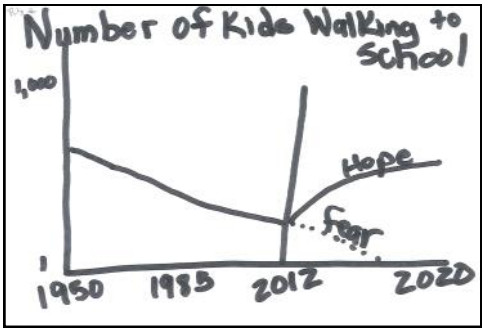
Unlike the community action teams loop in Figure 3, this loop has one "-" sign or polarity; because this is an odd number, it is a balancing loop (see B1— Active Transportation in Figure 4).

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

"I feel that, when a child has a school in their neighborhood, not only is there more parental involvement, but there is greater chance that children can bike and walk to school than with the decentralization of the school system. And in the smaller schools, you have more of an opportunity for school participation, school programs are not pressured by time, because there's not as many students there and neighborhood schools can help reverse the trend of childhood obesity." (Participant)

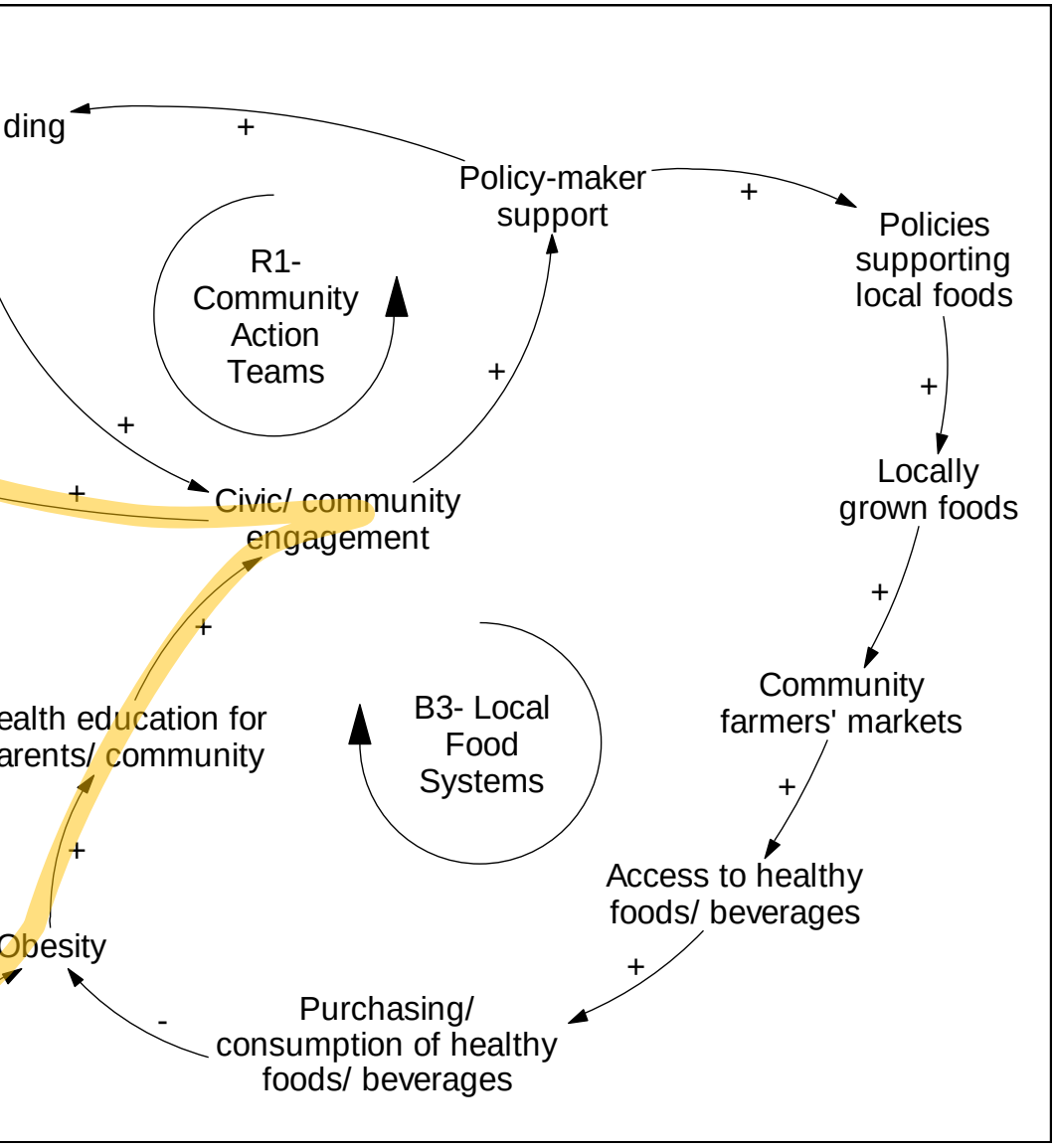
stabilizing influence to the original variable, respectively.

Some of these causal relationships may have more immediate effects (e.g., active transportation influence on physical activity) and other relationships may have delayed effects (e.g., physical activity influence on obesity). This delayed effect is noted using two hash marks through the middle of the arrow line (not included in Figure 4).



System Insights for *Knox County Healthy Kids, Healthy Communities*

In the behavior over time graphs, participants identified the number of kids walking to school decreasing since 1950 to 2012 with the hope that the number of kids walking to school will increase into the future (see behavior over time graph on the top right). Similarly, participants described the number of communities with sidewalks has decreased over time since 1960 to 2012 with the hope that the number of communities with sidewalks will increase into the future (see behavior over time graph on the bottom right).

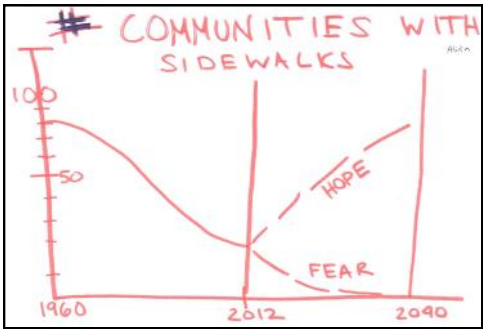


System insights can inform the partnership's next steps with active transportation, including:

- Infrastructure for pedestrians and bicyclists increases the number of families being active together; sidewalks and bike lanes — along with traffic calming and other safety measures — create opportunities for families to choose active rather than sedentary transportation modes.
- Parent knowledge and awareness is key to their engagement in efforts to increase healthy eating and active living and reduce childhood obesity; this knowledge and awareness increases their skills to interact with their children through cooking meals at home or engaging in physical activity.

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 types of trips are made by car, bike, and foot in communities? Who is using the current active transportation infrastructure and who is not (e.g., adults, children)?



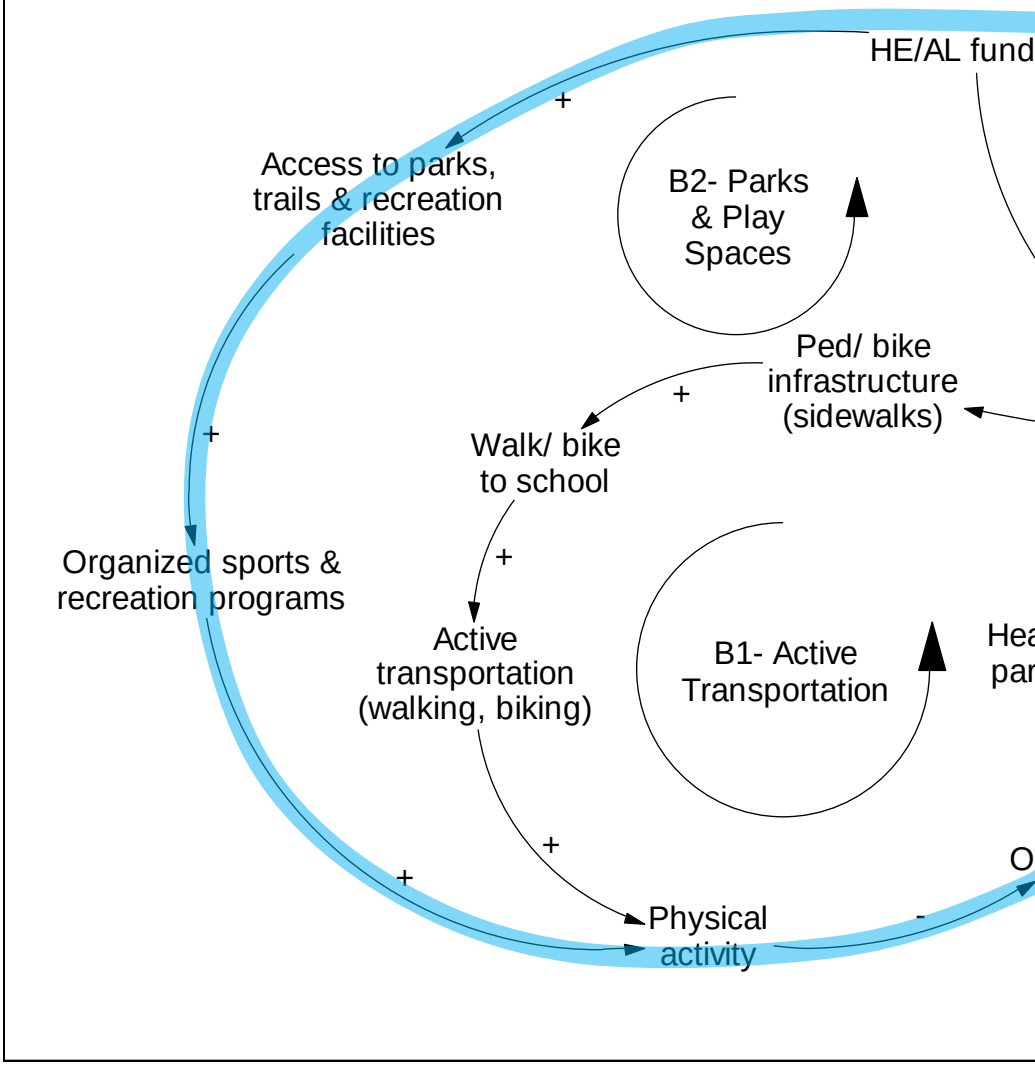
Parks and Play Spaces Feedback Loop

Highlighted in blue in Figure 5, the parks and play spaces feedback loop represents one of the *Knox County Healthy Kids, Healthy Communities* strategies to increase active living in Knox County, Tennessee .

Causal Story for Feedback Loop

Story A: Participants described with an increase in the access to parks, trails, and recreation facilities, there is an increase in the number of organized sports and recreation programs. With more organized sports and recreation programs, there is an increase in the amount of physical activity for residents, which decreases obesity. As obesity rates are decreasing, there is also a decrease in the need for health education for parents and the community as obesity is becoming less of a problem. With less health education, there is less civic and community engagement around obesity issues, which decreases the policy-maker support. With less policy-maker support, there is a decrease in the healthy eating and active living funding available, which decreases access to parks, trails, and recreation facilities.

Figure 5: Parks and Play Spaces Feedback Loop



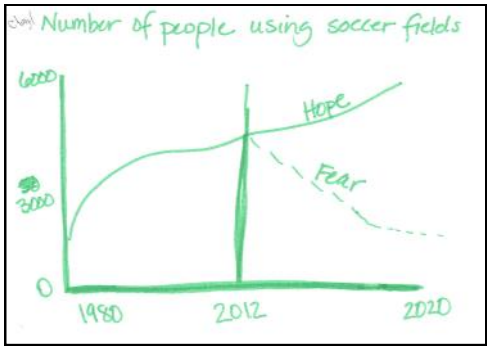
Story B: Alternatively, participants described with a decrease in the access to parks, trails, and recreation facilities, there is a decrease in the number of organized sports and recreation programs. With less organized sports and recreation programs, there is a decrease in the amount of physical activity for residents, which increases obesity. As obesity rates are increasing, there is also an increase in the need for health education for parents and the community as obesity is becoming more of a problem. With more health education, there is more civic and community engagement around obesity issues, which increases the policy-maker support. With greater policy-maker support, there is an increase in the healthy eating and active living funding available, which increases access to parks, trails, and recreation facilities.

Balancing Loop and Notation

Similar to the previous loop (see Figure 4), this one also represents a balancing loop (one "-" sign). Story A provides a good illustration of the reason why it is not advantageous to separate the feedback loops from the

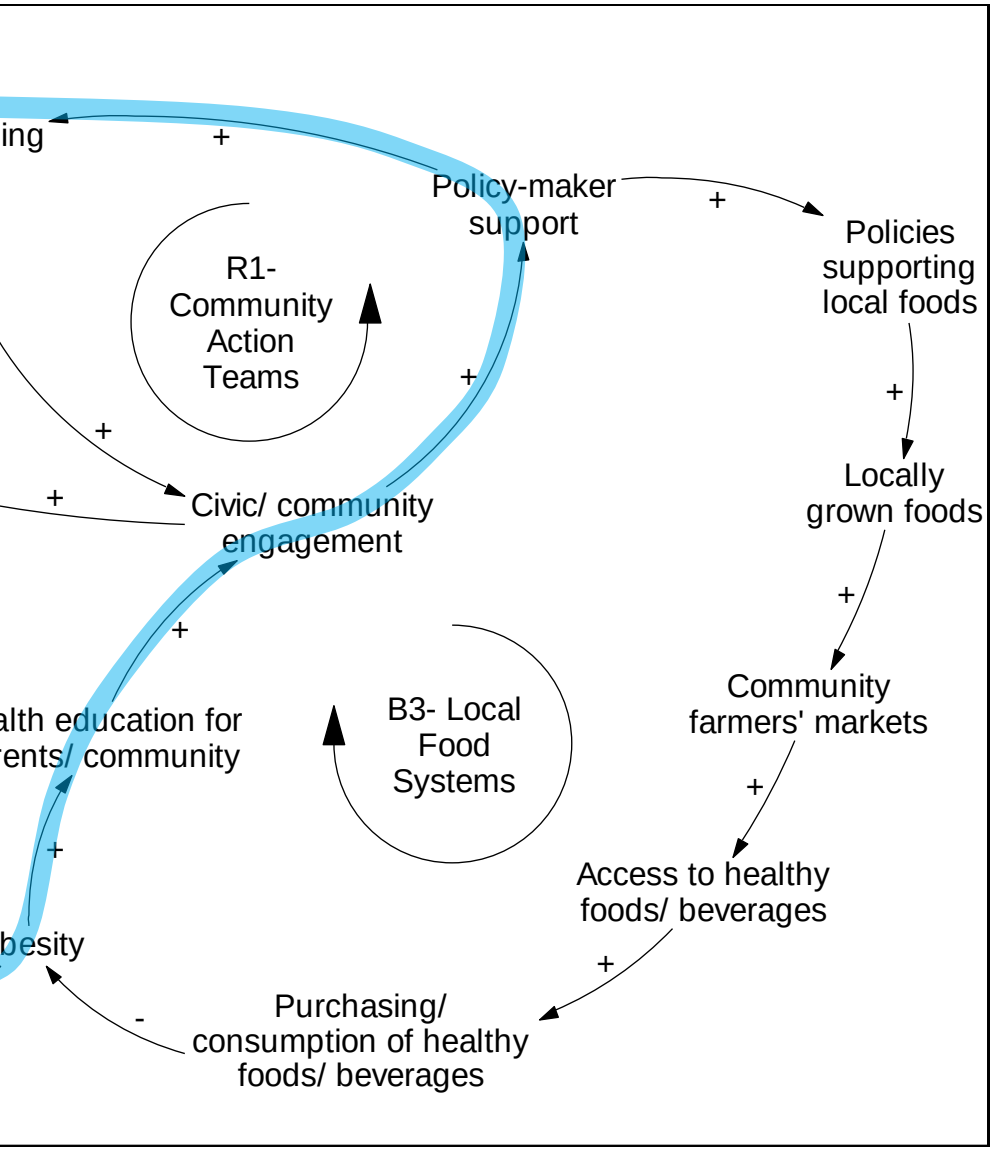
"Our children don't have anywhere to go to be actively involved because when there was a program open for all children to go down to the rec center and do things, out in the field, out on field trips, swimming; they just did things that kept the children, and they were eating good. But now, the children are, most of this summer, they're not going to have anywhere to go because the rec center isn't open." (Participant)

causal loop diagram (see Figures 1-2). For instance, while the healthy eating and active living funding may have an influence on access to parks, trails, and recreation facilities, many other factors influence access to parks, trails, and recreation facilities. In this case, examining this loop without the context of the other variables and loops may lead to inappropriate conclusions.



<u>System Insights for *Knox County Healthy Kids, Healthy Communities*</u>

In the behavior over time graphs exercise, participants described an increase in the number of people using soccer fields since 1980 to 2012 with the hope that the number of people using soccer fields will continue to increase into the futures (see behavior over time graph on the top right). However, participants identified a decrease in the number of recreational facilities available in the community since 1980 to 2012 with the hope that the number of recreation facilities in the community will change and increase into the future (see behavior over time graph on the bottom right).

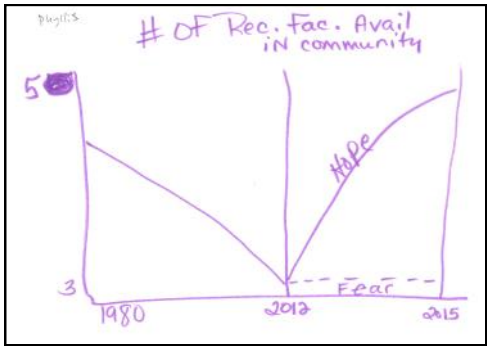


System insights for the partnership's parks and play spaces strategy efforts include:

- Parks, trails, and recreation facilities that facilitate both opportunities for physical activity and resident interaction and engagement support sustainability of the quality of these spaces by increasing collaboration of local partners that can generate resources to invest in these spaces.
- Public recreation facilities increase the health of community members and beautify their neighborhoods.
- "Upstream" efforts to increase community and social engagement in order to draw the attention of policy– and decision-makers to the importance of health-centered community design leads to increases in access to safe parks, trails, and outdoor facilities.

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

- What are the optimal numbers and types of public recreation facilities for a neighborhood or urban area?
- What are the appropriate types and numbers of extra-curricular programs to support increased outdoor activity among children and adolescents?



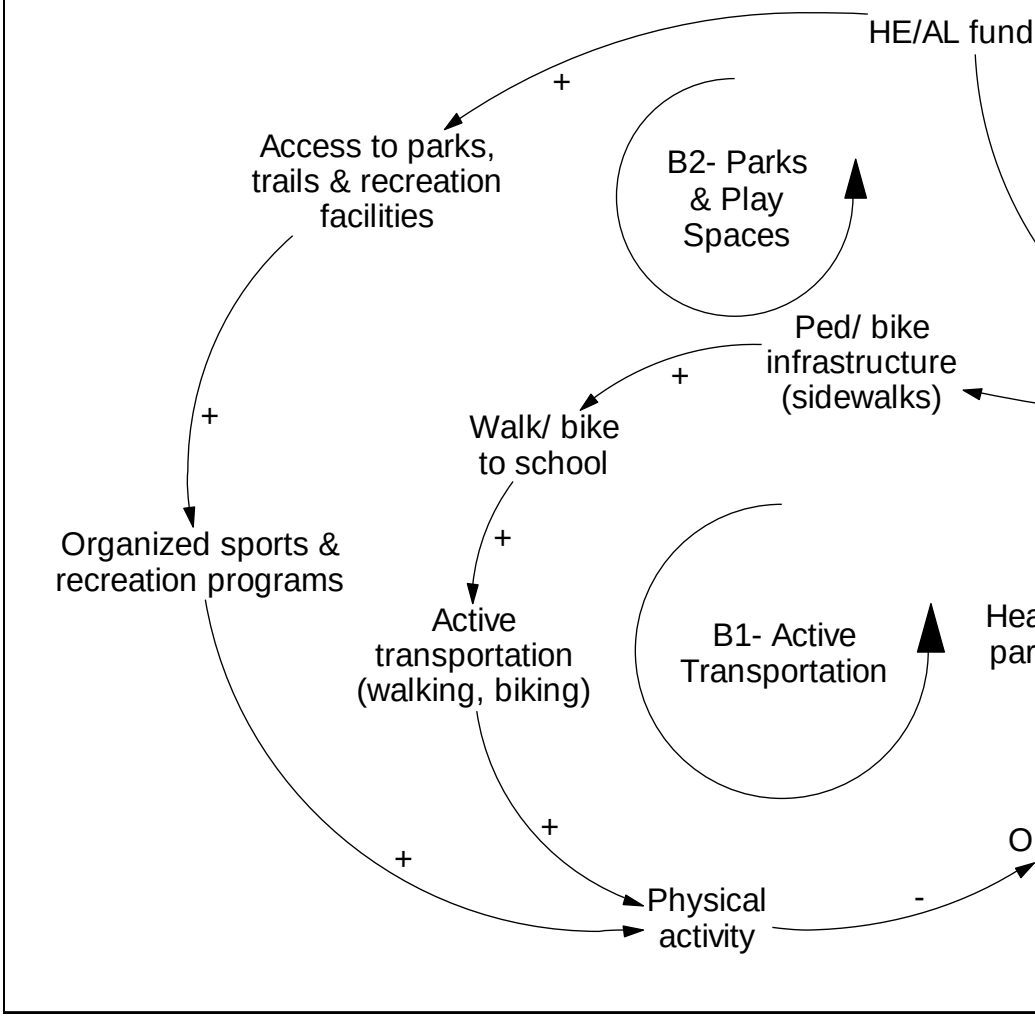
Local Food Systems (Food Policy Council) Feedback Loop

Highlighted in red in Figure 6, the local food systems feedback loop represents one of the *Knox County Healthy Kids, Healthy Communities* strategies to increase healthy eating in Knox County, Tennessee .

Causal Story for Feedback Loop

Story A: With more policies supporting local foods, there is in a increase in the amount of locally grown foods in the community. As more locally grown foods are available, there is an increase in the number and availability of produce at the community farmers' markets, which increases access to healthy foods and beverages. As more residents have access to healthy foods and beverages, there is an increase in the purchasing and consumption of the healthy foods and beverages, which decreases obesity. As obesity rates are decreasing, there is also a decrease in the need for health education for parents and the community as obesity is becoming less of a problem. With less health education, there is less civic and community engagement — particularly the food policy council — around obesity issues, which decreases the policy-maker support. With less policy-maker support, there is a decrease in the interest to work on policies supporting local foods.

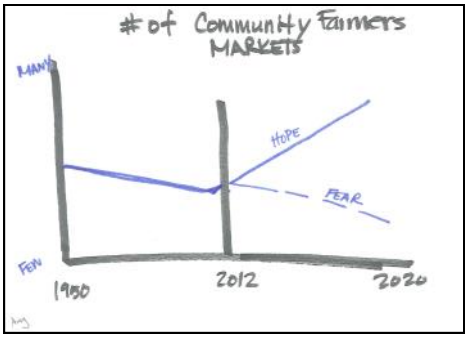
Figure 6: Local Food Systems (Food Policy Council) Feedback Loop



Story B: Alternatively, with less policies supporting local foods, there is in a decrease in the amount of locally grown foods in the community. As less locally grown foods are available, there is a decrease in the number and availability of produce at the community farmers' markets, which decreases access to healthy foods and beverages. As less residents have access to healthy foods and beverages, there is a decrease in the purchasing and consumption of the healthy foods and beverages, which increases obesity. As obesity rates are increasing, there is also a increase in the need for health education for parents and the community as obesity is becoming more of a problem. With more health education, there is more civic and community engagement — particularly the food policy council — around obesity issues, which increases the policy-maker support. With greater policy-maker support, there is an increase in the interest to work on

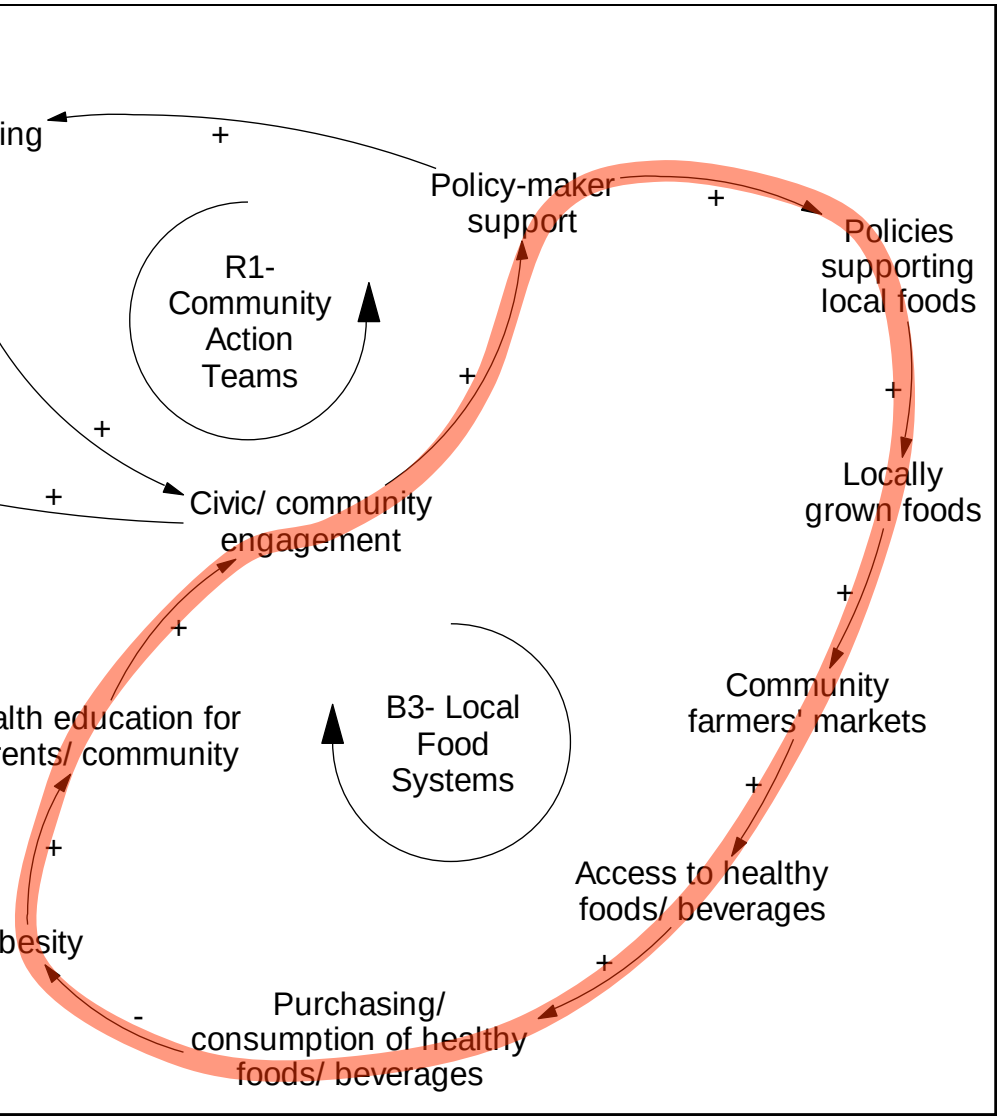
"In my neighborhood, and I'm sure in a lot of neighborhoods, children are not eating properly, and they tend to eat a lot of junk food, frozen meals that you can pop in the microwave, and parents, or whoever is taking care of them are not feeding them fresh, good vegetables. I think food stamps have a large play into that because the parents don't want to cook and they buy quick things from the grocery store. [I don't see people using food stamps to buy] fresh foods, milk, and things like that—healthy food—and because of this, they are going to have a bleak future. So it's important that we educate our parents and encourage them. My mission is to have a community garden to help us with that." (Participant)

policies supporting local foods.



Balancing Loop and Notation

Similar to the previous loops (see Figure 4 & 5), this is a balancing loop (one "-" sign). In addition, it includes causal relationships representing more immediate effects (e.g., community farmers' markets influence on access to healthy foods and beverages), and, potentially, delayed effects (e.g., purchasing and consumption of healthy foods and beverages influence on obesity).



System Insights for *Knox County Healthy Kids, Healthy Communities*

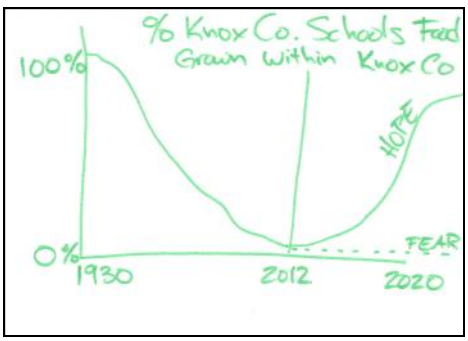
In the behavior over time graphs exercise, participants described a decrease in the number of community farmers' markets since 1950 to 2011 with a slight increase in the number of community farmers' markets within a year (2011 to 2012). The hope is that the number of community farmers' markets will continue to increase into the future (see behavior over time graph on the top right). Additionally, participants also described a decrease in the percentage of Knox County Schools with food grown locally since 1930 to 2012 with the hope that the locally grown food in Knox County will become available in the school system in the future (see behavior over time graph on the bottom right).

System insights for the partnership's local food systems efforts include:

- A strategic focus of the food policy council on increasing the number of and/or participation in community and school gardens or small farms has the added benefit of rallying community support for the council.
- Non-traditional partners with expertise in community engagement and organizing enhance more traditional advocacy approaches targeting policy– and decision-makers.

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

- What is the proportion of unhealthy food and beverage products to healthy food and beverage products sold by local food vendors (e.g., farmers' markets, corner stores, grocery stores)? How do these products differ by cost, product placement within the stores, and marketing or signage in and around the stores?
- What healthy foods and beverages are most likely to purchased and consumed in communities? Does this vary by subpopulation?



Opportunities for Systems Thinking in Knox County, Tennessee

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 *Knox County Healthy Kids, Healthy Communities* partners, this storybook also summarized the healthy eating, active living, partnership and community capacity, social determinants, and health and health behaviors subsystems in the Knox County causal loop diagram as well as six specific feedback loops corresponding to the partnership's primary strategies.

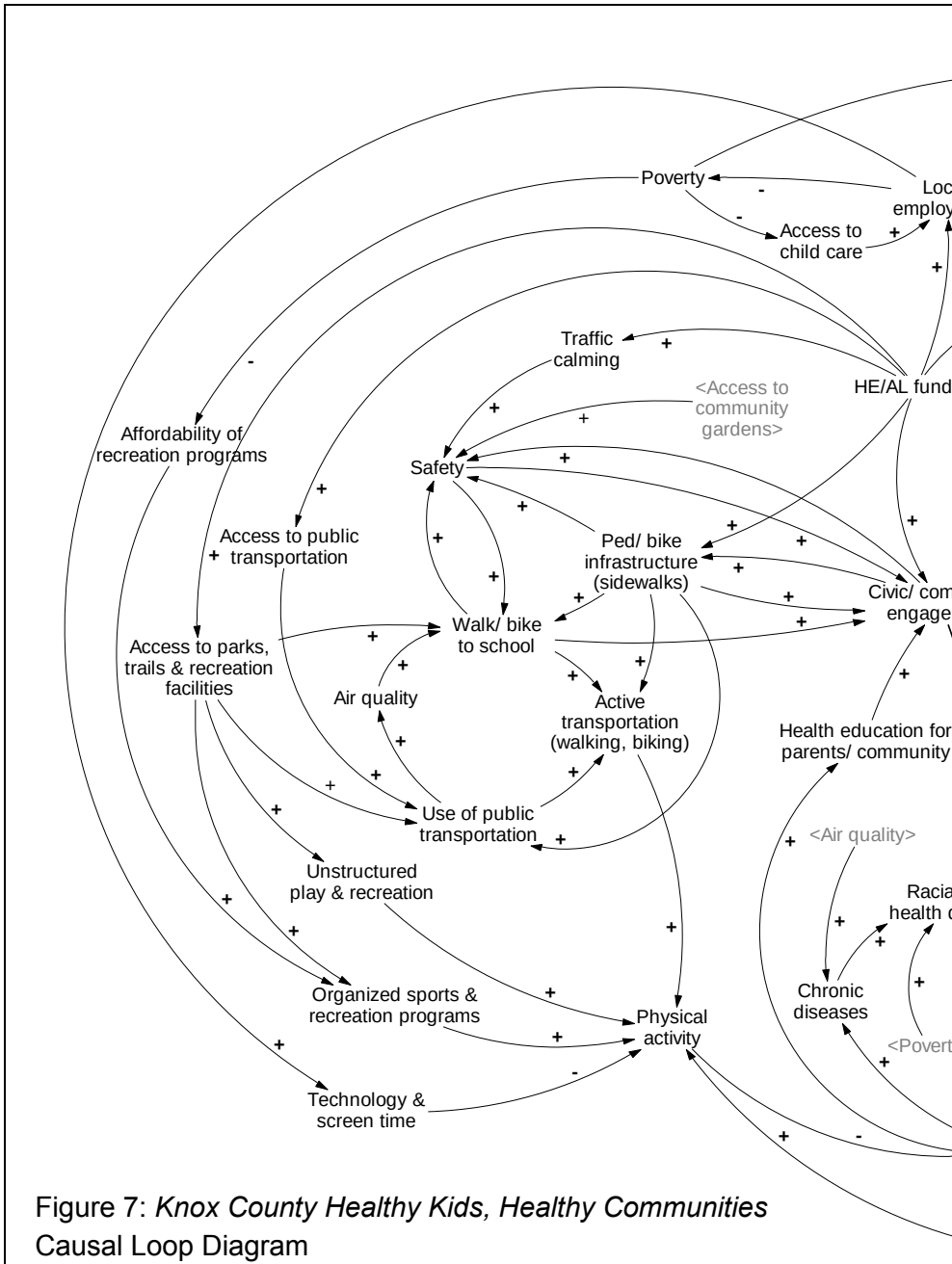


Figure 7: *Knox County Healthy Kids, Healthy Communities* Causal Loop Diagram

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.

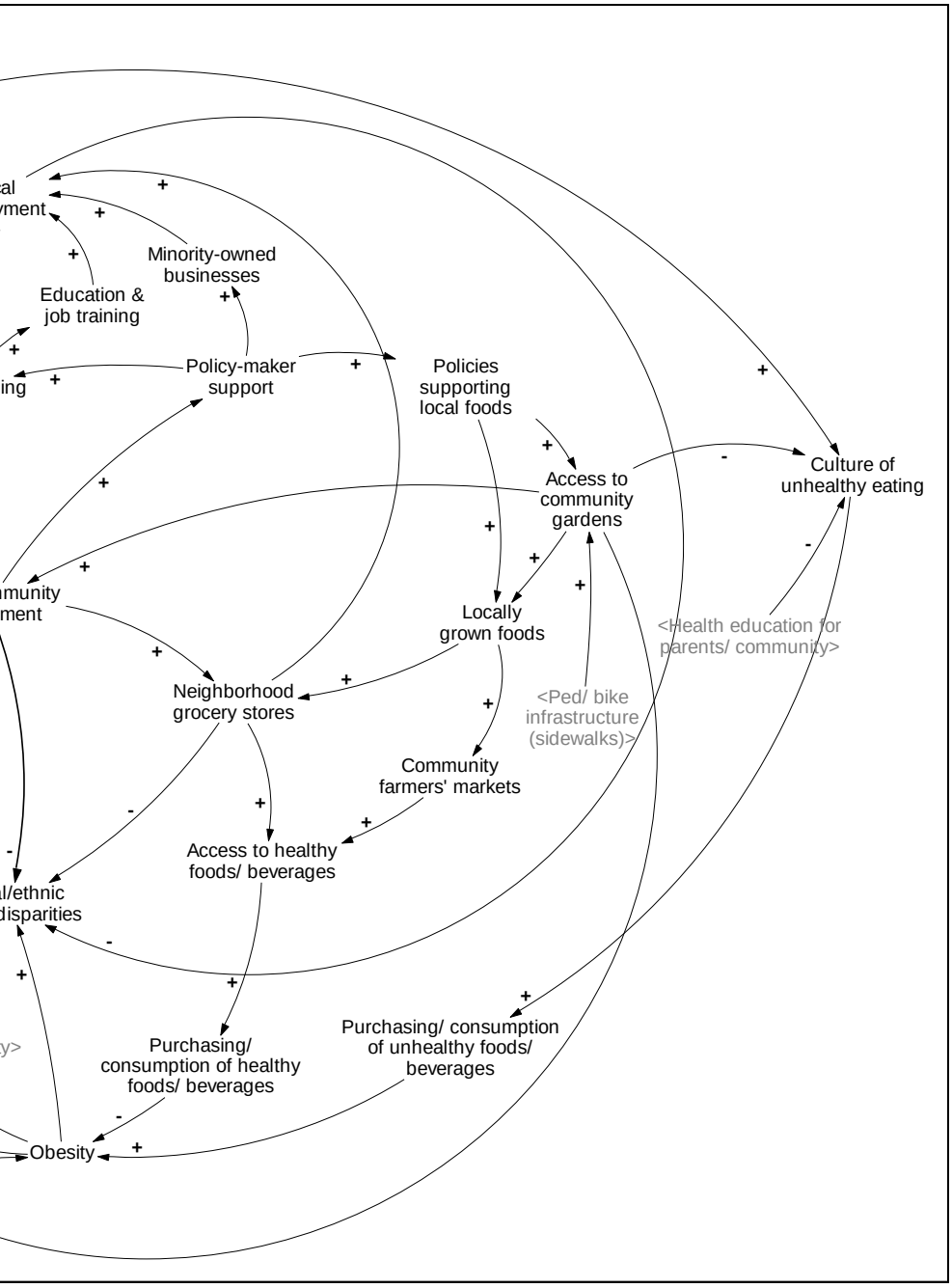
This represented a first attempt to collectively examine the range of things that affect or are affected by policy, system, and environmental changes in Knox County, Tennessee to promote healthy eating and active living as well as preventing childhood overweight and obesity.

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

- the participants represent a sample of the *Knox County Healthy Kids, Healthy Communities* 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 affordability of health insurance, sense of hope, children able/ prepared to learn in school, car dependence, traffic crashes (ped/bike), perceptions of crime, cost of living, schools in neighborhoods, family/ parental involvement, prescription medications, school PE, recess & physical activity, stress of living as a minority, affordability of unhealthy foods/ beverages, corporatization of food production, distribution & retail, small farmland producing food, government nutrition assistance, affordability of healthy foods/beverages; 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 Knox County 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 *Knox County Healthy Kids, Healthy Communities* 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/

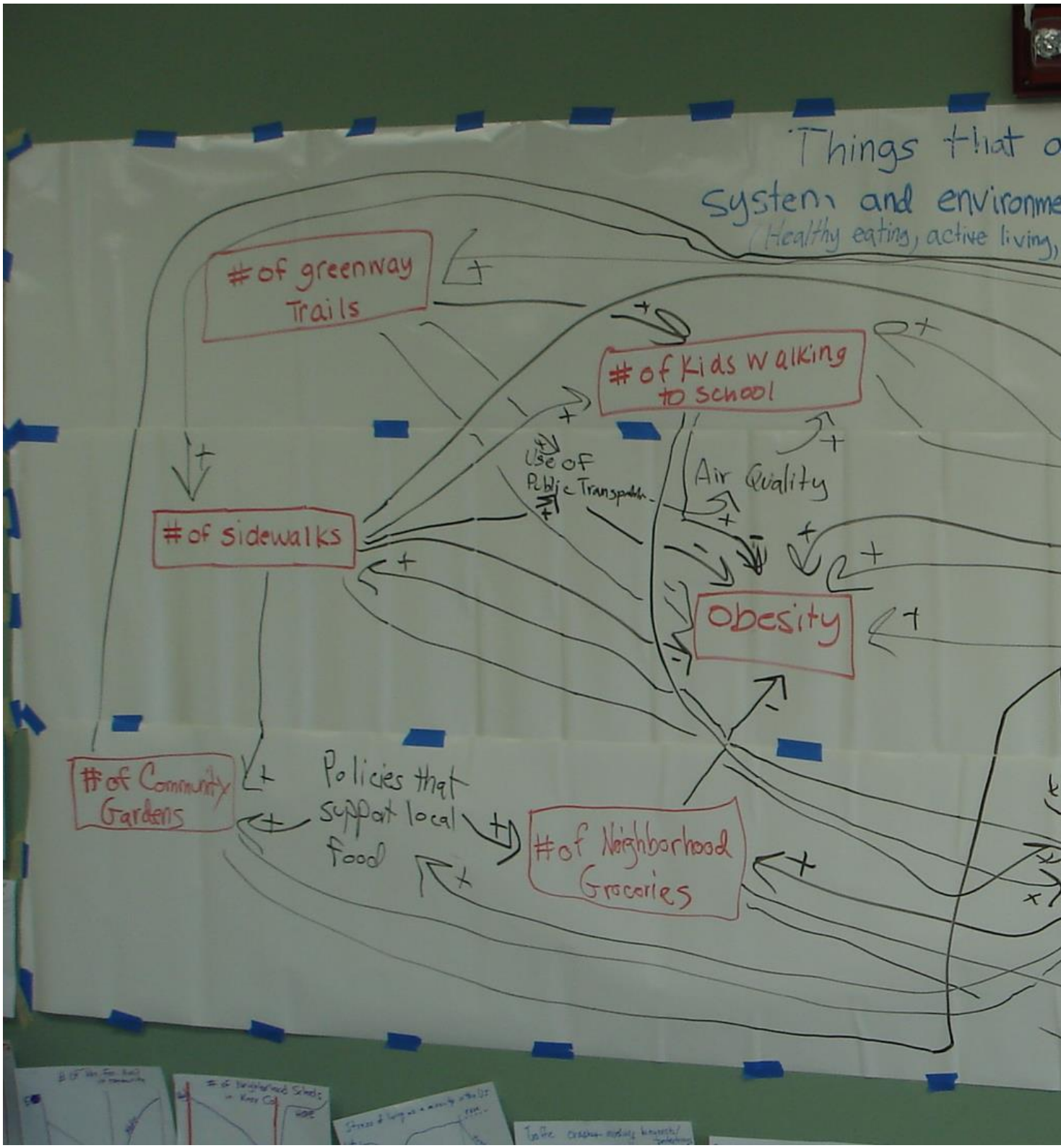
Vennix, J. (1996). Group model building. New York, John Wiley & Sons.

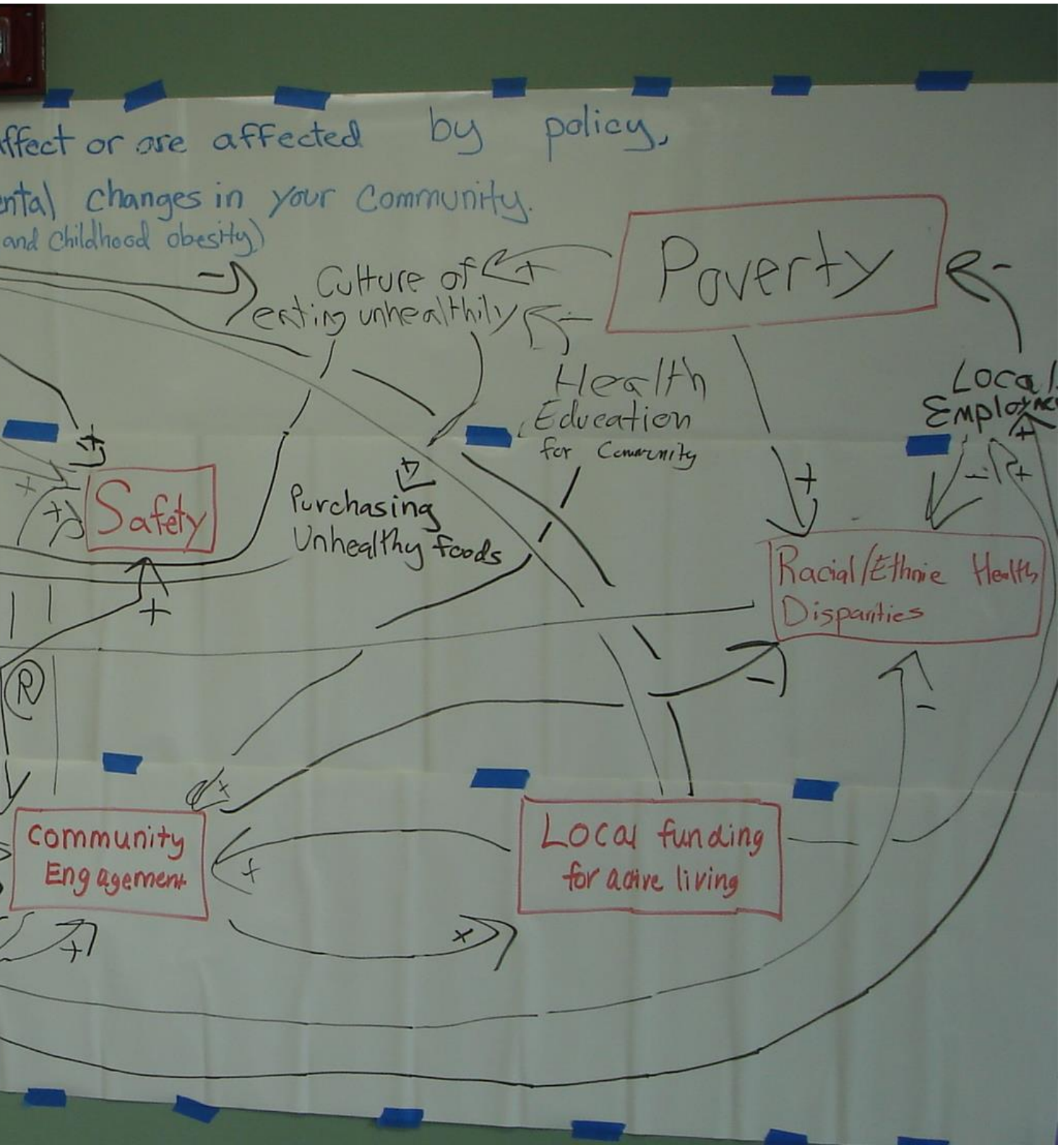
Zagonel, A. and J. Rohrbaugh (2008). Using group model building to inform public policy making and implementation. Complex Decision Making. H. Qudart-Ullah, J. M. Spector and P. I. Davidsen, Springer-Verlag: 113-138.

Appendix A: Behavior Over Time Graphs Generated during Site Visit

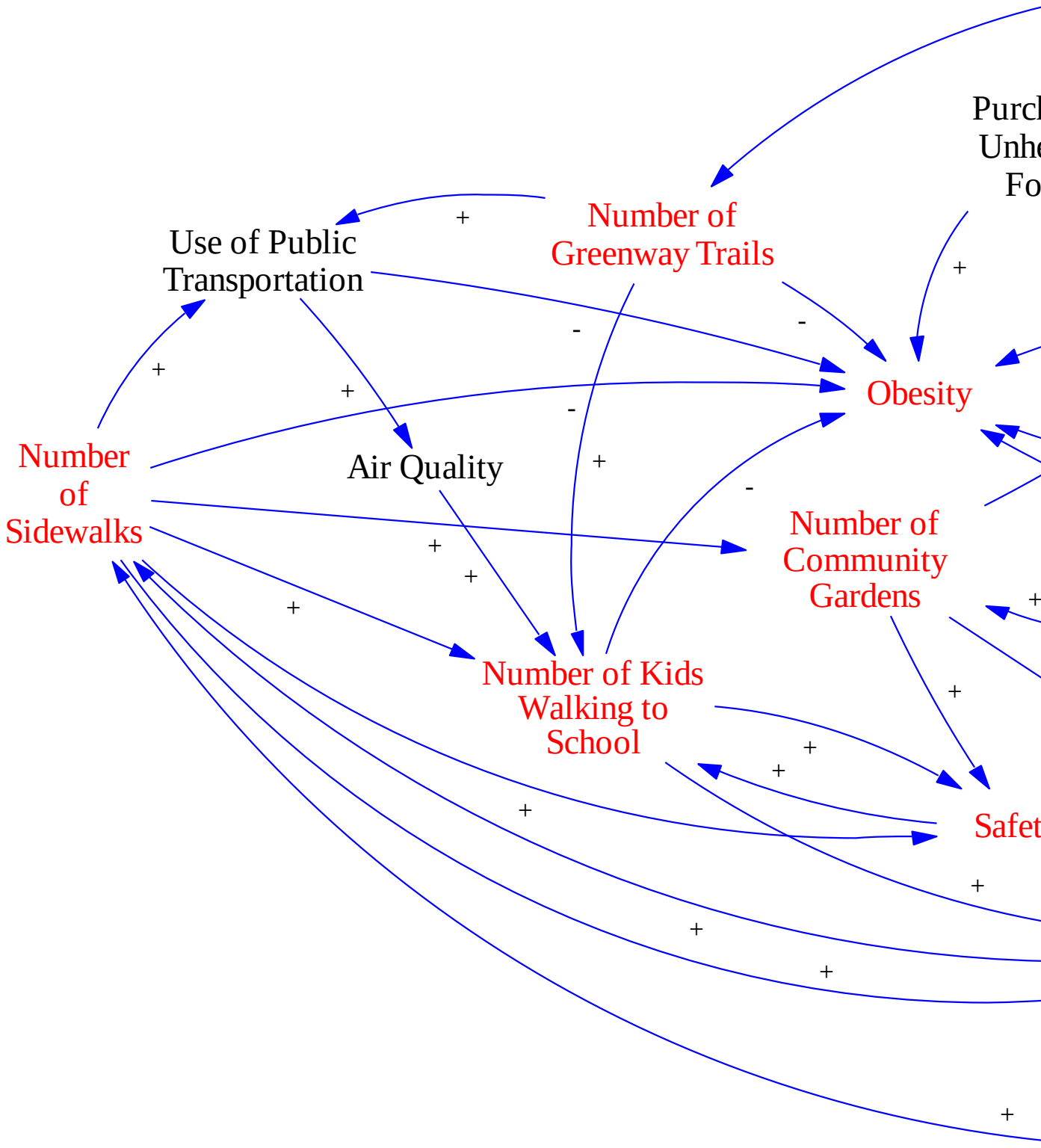
Knox County, Tennessee: *Knox County Healthy Kids, Healthy Communities*	
Categories	**Number of Graphs**
Active Living Behavior	6
Active Living Environments	7
Funding	0
Healthy Eating Behavior	1
Healthy Eating Environments	6
Marketing and Media Coverage	0
Obesity and Long Term Outcomes	8
Partnership & Community Capacity	1
Policies	4
Programs & Promotions (Education and Awareness)	0
Social Determinants of Health	13
Total Graphs	**46**

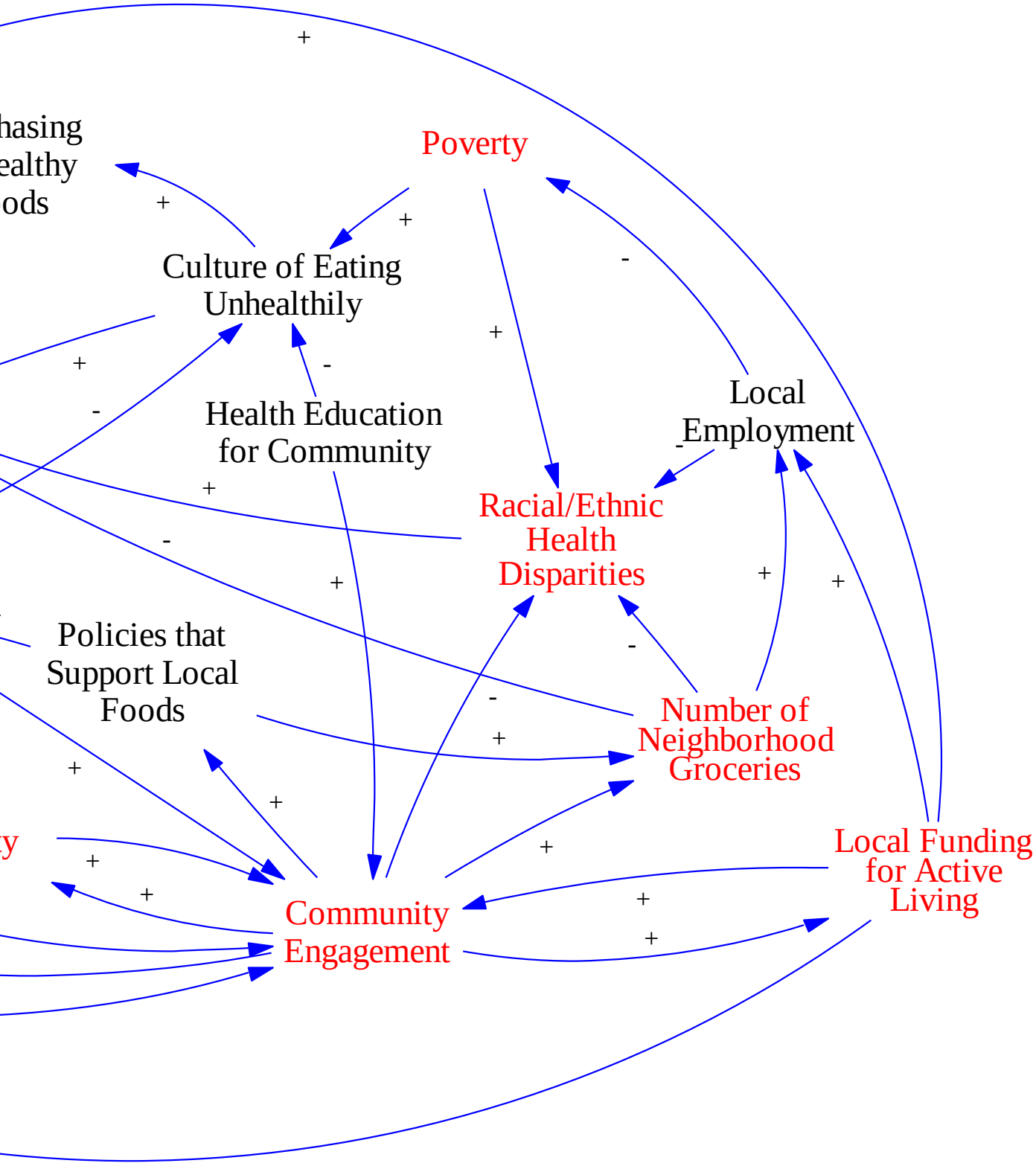
Appendix B: Photograph of the Original Version of the *Knox County Healthy Kids, Healthy Communities* Causal Loop Diagram



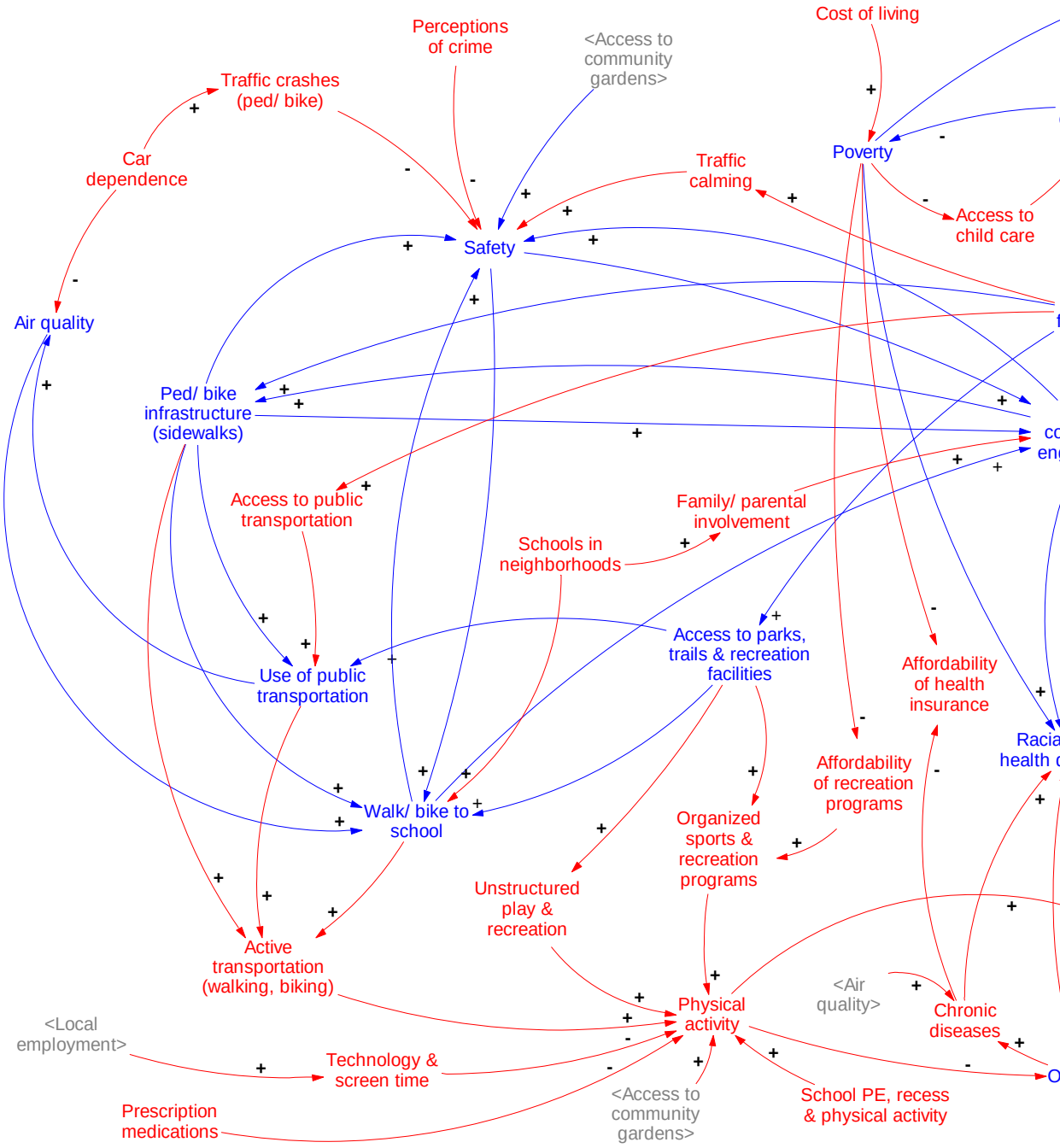

affect or are affected by policy.
ental changes in your community.
and childhood obesity)
Culture of eating unhealthily
Poverty
Health Education for Community
Local Employment
Safety
Purchasing Unhealthy foods
Racial/Ethnic Health Disparities
Community Engagement
Local funding for active living

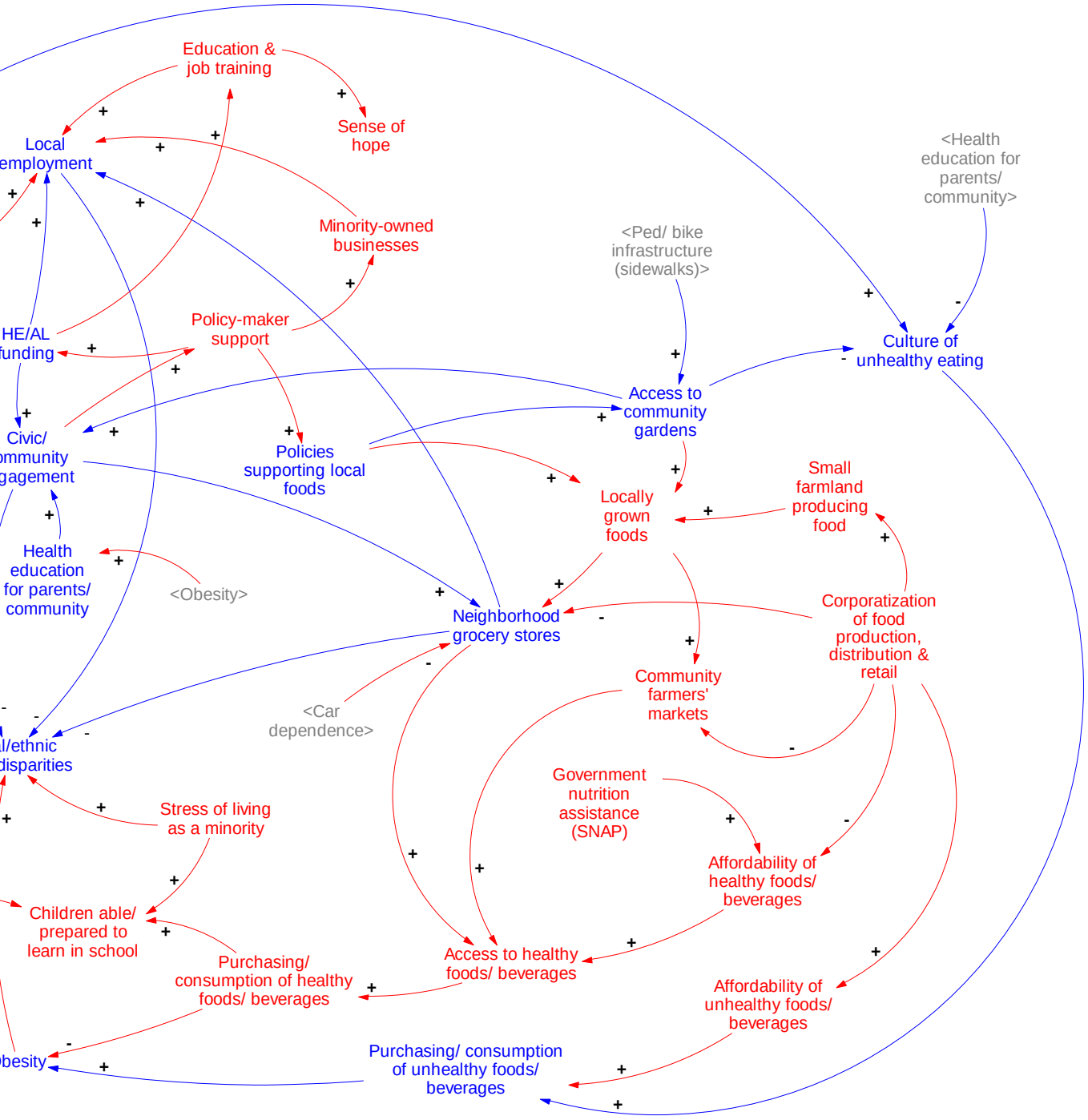
Appendix C: Original Translation of the Causal Loop Diagram into Vensim PLE



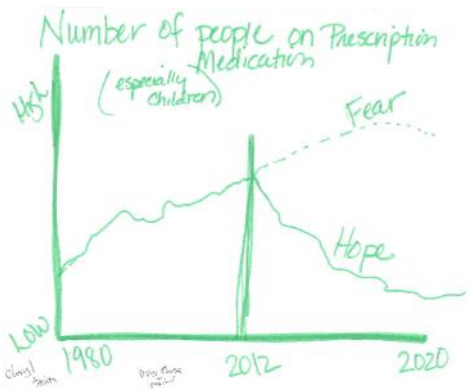

hasing
ealthy
ods
Poverty
Culture of Eating
Unhealthily
Health Education
for Community
Local
Employment
Racial/Ethnic
Health
Disparities
Policies that
Support Local
Foods
Number of
Neighborhood
Groceries
Local Funding
for Active
Living
Community
Engagement
+
-

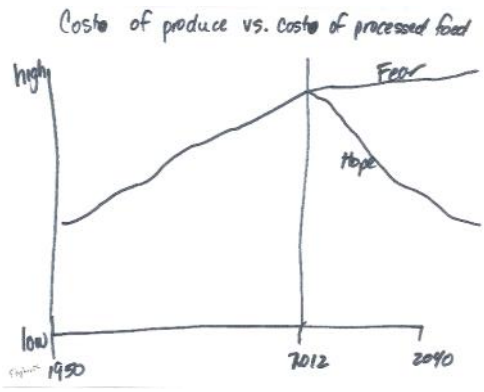
Appendix D: Transcript Translation of the Causal Loop Diagram into Vensim PLE

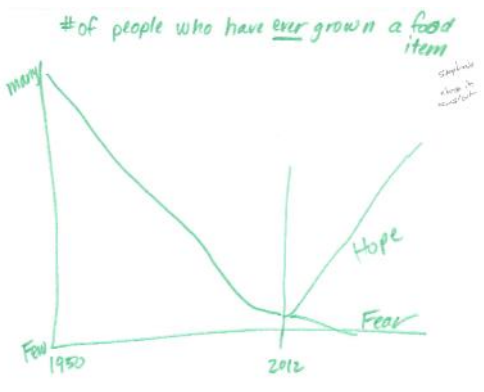


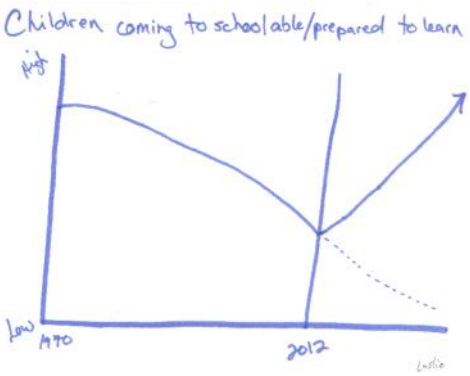

Education & job training
Sense of hope
Local employment
Minority-owned businesses
<Health education for parents/ community>
<Ped/ bike infrastructure (sidewalks)>
Policy-maker support
HE/AL funding
Culture of unhealthy eating
Access to community gardens
Civic/ ommunity gagement
Policies supporting local foods
Locally grown foods
Small farmland producing food
Health education for parents/ community
<Obesity>
Neighborhood grocery stores
Corporatization of food production, distribution & retail
Community farmers' markets
<Car dependence>
l/ethnic disparities
Government nutrition assistance (SNAP)
Stress of living as a minority
Affordability of healthy foods/ beverages
Children able/ prepared to learn in school
Access to healthy foods/ beverages
Purchasing/ consumption of healthy foods/ beverages
Affordability of unhealthy foods/ beverages
besity
Purchasing/ consumption of unhealthy foods/ beverages

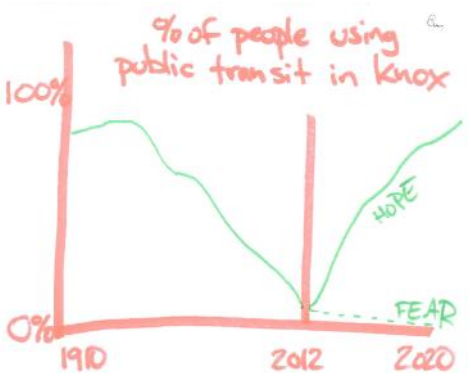
Appendix E: Behavior Over Time Graphs not Represented in the Storybook

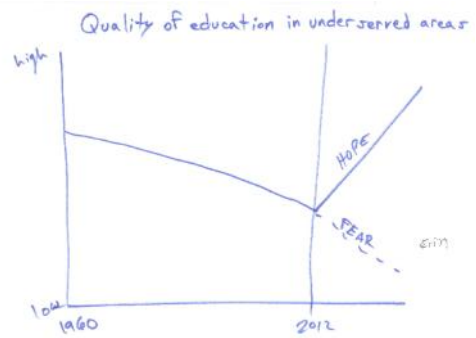


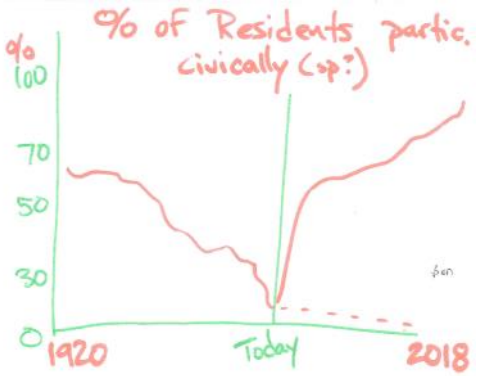


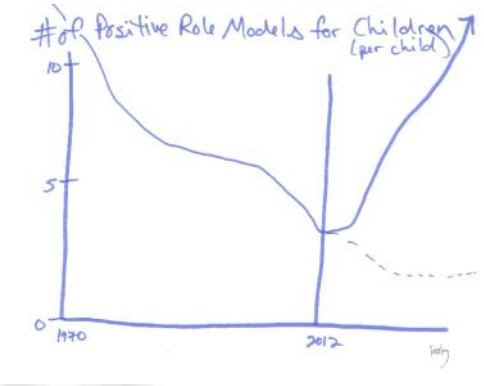


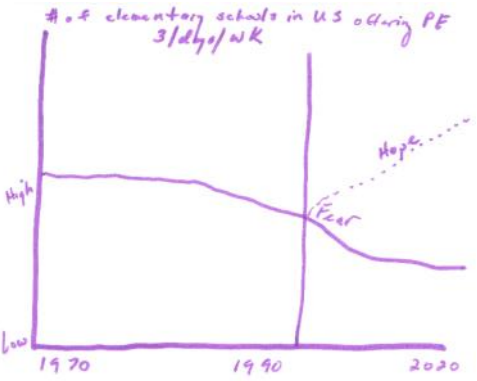


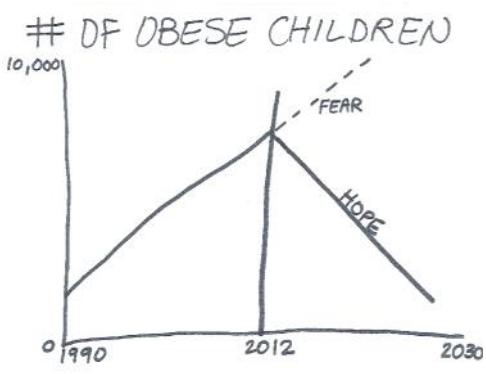


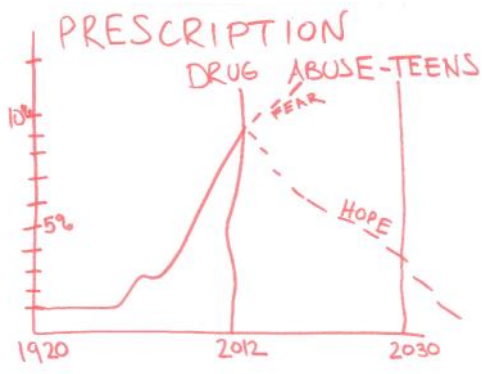


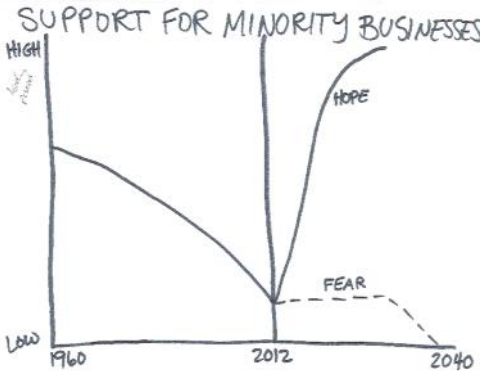


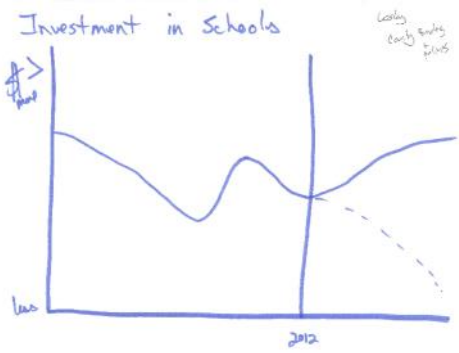


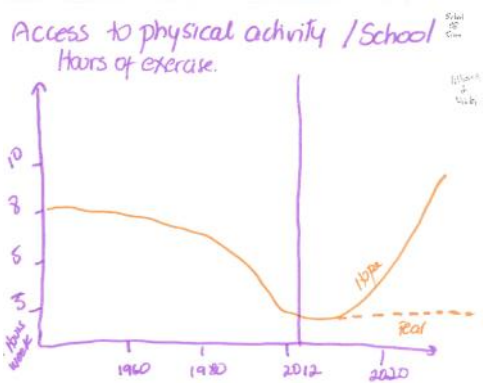




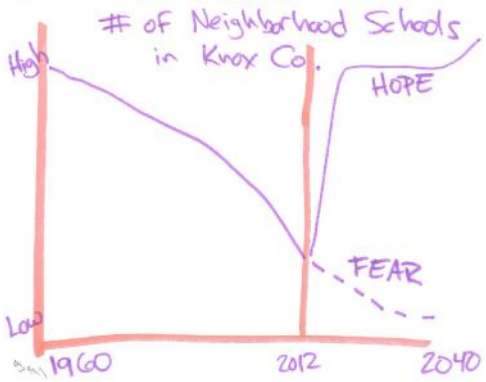



SUPPORT FOR MINORITY BUSINESSES
HIGH
HOPE
FEAR
LOW
1960
2012
2040

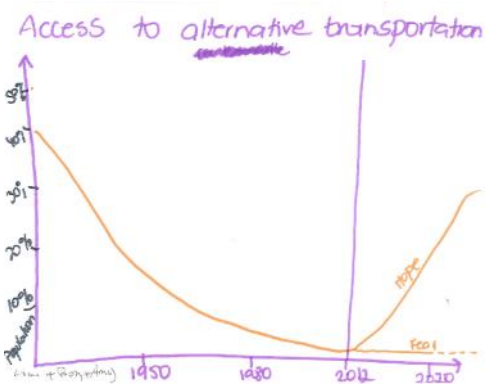

Investment in Schools
2012


Access to physical activity / School Hours of exercise.
10
8
6
5
1960
1980
2012
2020
Real


Parents Walking + Playing with children outside
more
less
Hope
fear
1950
1980
2012
2020

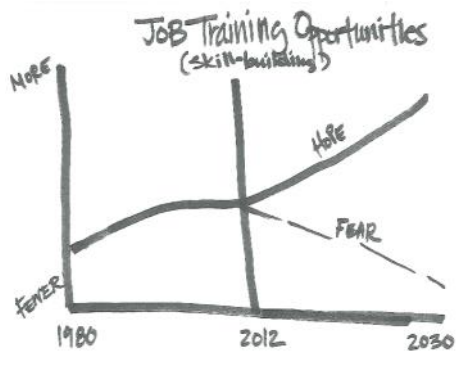

# of Neighborhood Schools in Knox Co.
High
Low
HOPE
FEAR
1960
2012
2040

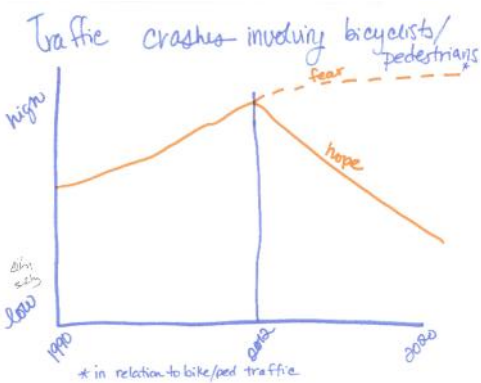

AIR QUALITY
GOOD
Medium
POOR
HOPE
FEAR
1970
2012
2020

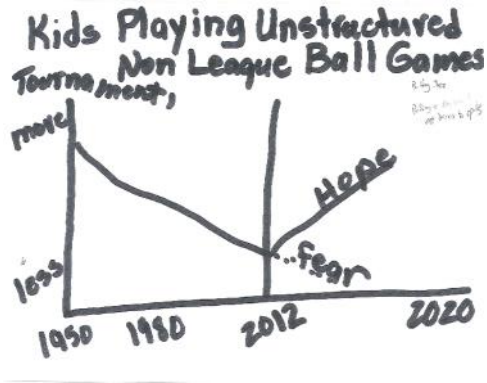

Access to alternative transportation
1950
1980
2012
2020
HOPE
FEAR

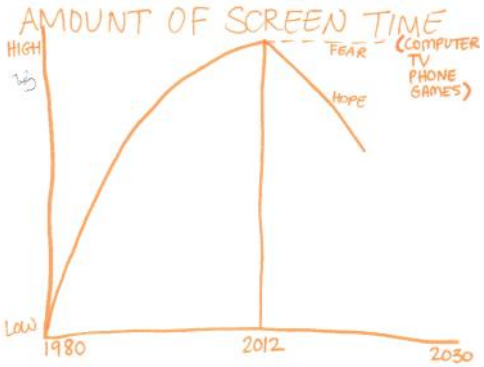

Stress of living as a minority in the US
high
low
FEAR
HOPE
1960
2012

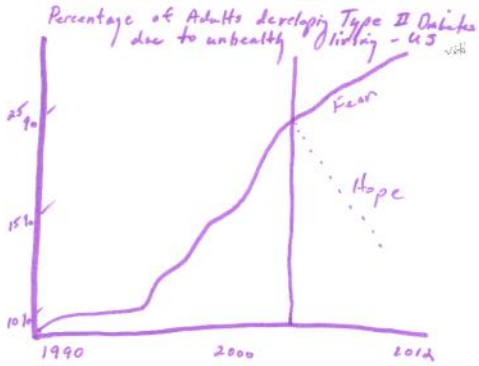

% RESIDENTS ON FOOD STAMPS
$0
FEAR
HOPE
0
1970
2012
2030


JOB Training Opportunities
(skill-building)
HOPE
HOPE
FEAR
FEWER
1980
2012
2030

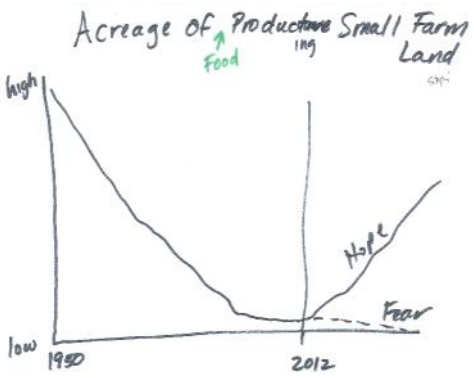

Traffic crashes involving bicyclists/pedestrians*
high
low
fear
hope
1990
2012
2030
* in relation to bike/ped traffic

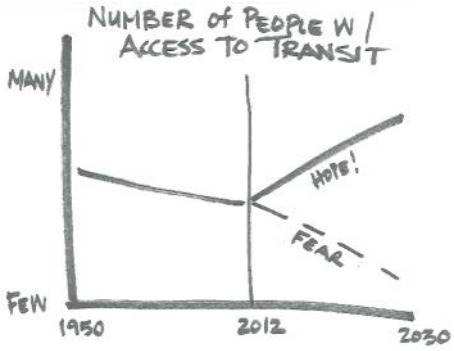

Kids Playing Unstructured Non League Ball Games
Tournaments,
more
less
Hope
fear
1950
1980
2012
2020

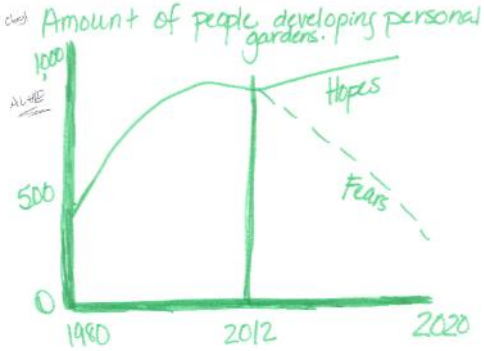

AMOUNT OF SCREEN TIME
HIGH
FEAR
(COMPUTER TV PHONE GAMES)
HOPE
LOW
1980
2012
2030

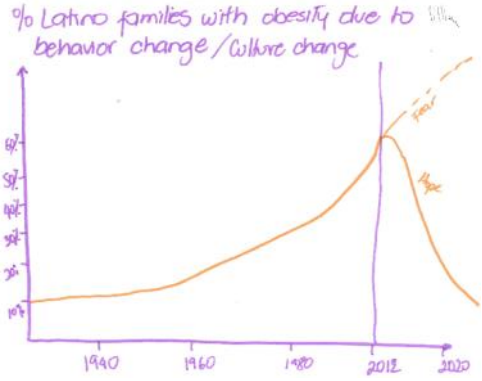

Percentage of Adults developing Type II Diabetes due to unhealthy living - US
25%
15%
10%
Fear
Hope
1990
2000
2012

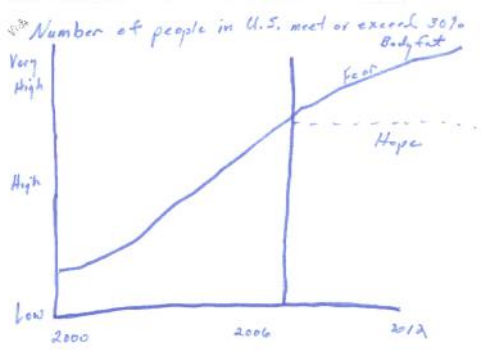

FEELING SAFE AT HOME
(HOUSE, NEIGHBORHOOD, COMMUNITY)
HIGH
HOPE
FEAR
LOW
1990
2012
2030

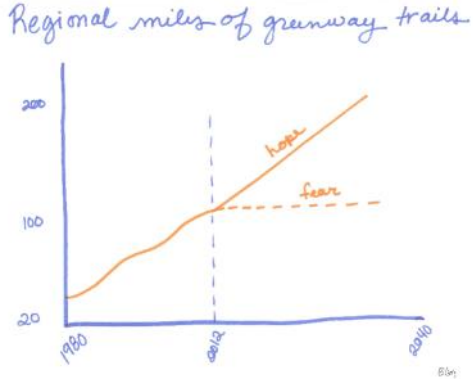

Acreage of Productive Small Farm Land
Food
ing
high
Hope
Fear
low
1950
2012


NUMBER of PEOPLE W/ ACCESS TO TRANSIT
MANY
HOPE!
FEAR
FEW
1950
2012
2030

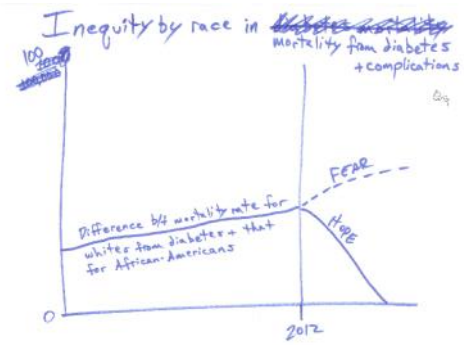

Amount of people developing personal gardens.
1,000
500
0
Hopes
Fears
1980
2012
2020

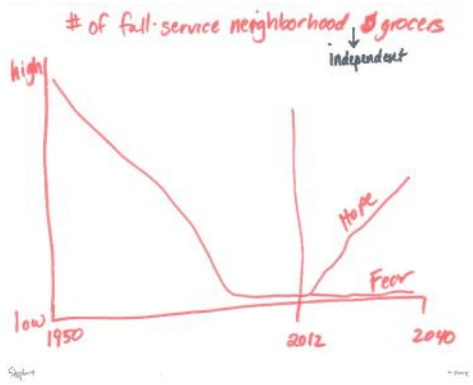

% Latino families with obesity due to behavior change / culture change
Fear
Hope
1940
1960
1980
2012
2020

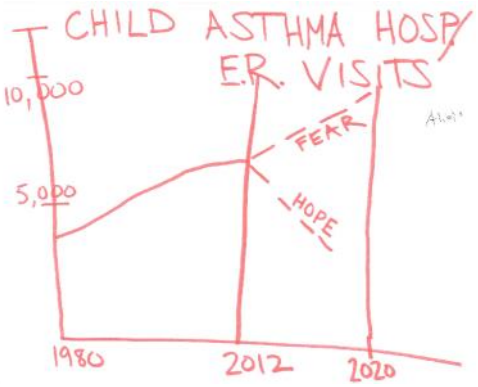

Number of people in U.S. meet or exceed 30% Body fat
Very High
High
Low
Fear
Hope
2000
2006
2012

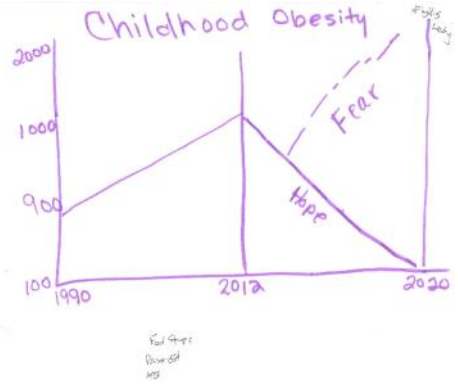

Regional miles of greenway trails
200
100
20
hope
fear
1980
2012
2040


OF CARS
FEAR
HOPE
100
1950
2012
2030


Inequity by race in
Mortality from diabetes + complications
FEAR
HOPE
Difference b/t mortality rate for whites from diabetes + that for African-Americans
0
2012


# of full-service neighborhood grocers
Independent
high
Hope
Fear
low
1950
2012
2040


CHILD ASTHMA HOSP/ E.R. VISITS
10,000
5,000
FEAR
HOPE
1980
2012
2020


Childhood Obesity
2000
1000
900
100
Fear
Hope
1990
2012
2020