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Identifying opportunities for collective action around community nutrition programming through participatory systems science

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Abstract

Purpose—To apply principles of group model building (GMB), a participatory systems science approach, to identify barriers and opportunities for collective impact around nutrition programming to reduce cancer risk for immigrant communities in an urban environment.

Methods—We convened four in-person workshops applying GMB with nine community partners to generate causal loop diagrams (CLDs)—a visual representation of hypothesized causal relationships between variables and feedback structures within a system. GMB workshops prompted participants to collaboratively identify programmatic goals and challenges related to (1) community gardening, (2) nutrition education, (3) food assistance programs, and (4) community-supported agriculture. Participants then attended a plenary session to integrate findings from all workshops and identify cross-cutting ideas for collective action.

Results—Several multilevel barriers to nutrition programming emerged: (1) food policies center the diets and practices of White Americans and inhibit culturally tailored food guidelines and funding for culturally appropriate nutrition education; (2) the lack of culturally tailored nutrition education in communities is a missed opportunity for fostering pride in immigrant food culture and sustainment of traditional food practices; and (3) the limited availability of traditional ethnic produce in food assistance programs serving historically marginalized immigrant communities increases food waste and worsens food insecurity.

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Declarations

Competing interests Not applicable.

Ethical approval and consent to participate This study was determined to be exempt by the NYU Grossman School of Medicine Institutional Review Board.

Consent for publication Not applicable.

Conclusion—Emergent themes coalesced around the need to embed cultural tailoring into all levels of the food system, while also considering other characteristics of communities being reached (e.g., language needs). These efforts require coordinated actions related to food policy and advocacy, to better institutionalize these practices within the nutrition space.

Keywords

Community engagement; Food system; Systems science; Cultural adaptation; Immigrant communities; Cancer disparities

Background

Cancer is a leading cause of death worldwide and new cancer cases are estimated to increase 47 percent from 19.3 million cases in 2020 to 28.4 million in 2040 [1]. Concurrent with cancer disparities is the unequal burden of cardiometabolic morbidities experienced by immigrant and minoritized communities [2–5], which may contribute in part to suboptimal cancer outcomes [6, 7]. Given the increasing global cancer burden and disproportionate burden on communities of color [8, 9] and communities with low income [10], evidence-based interventions and recommendations that address related cardiometabolic risks factors, such as obesity and nonalcoholic fatty liver disease (NAFLD), diet and nutrition are particularly important. Existing cancer disparities are amplified by impacts from the COVID-19 pandemic—including changes to the local food environment, stress related to increased anti-immigrant rhetoric and continued violence and increasing food insecurity [11–13]. Recommendations for cancer prevention and survival from the World Cancer Research Fund Network and American Institute for Cancer Research have prioritized modifiable lifestyle factors like diet and nutrition in their recommendations to reduce cancer incidence worldwide [14]. However, evidence-based cancer interventions are not typically culturally and linguistically developed and tailored for immigrant populations, including for Asian American and Latine populations, which may increase their risk of long-term chronic disease and poor health outcomes [2–5, 15].

The COVID-19 pandemic exposed the existing structural inequities facing immigrant and minoritized communities, such as the dramatic increase in food insecurity. Asian and Latine households with food insecurity face unique challenges, such as fear to go out to buy food or transportation barriers [16]. In a community-based sample of Asian American adults (n = 1,217) in New York City (NYC), accessing food was the most reported concern [13]. Another study found that the COVID-19 pandemic (May to July 2020) resulted in higher closures of grocery stores, restaurants, and produce vendors in Chinese ethnic neighborhoods compared to control neighborhoods [11]. There was a 40% reduction in Asian produce vendors, contributing to an estimated 20% reduction in fruit and vegetable consumption in impacted neighborhoods [11]. These burdens are compounded by increased fear among immigrant communities broadly related to public charge and hate incidents that negatively impact their mental health and sense of security [17].

The structural inequities and resulting health disparities experienced by immigrant and minoritized communities are complex and intractable [18, 19]. Interacting factors at multiple

levels drive and sustain these inequities across the life course [20]. Devising effective strategies requires a simplified depiction of the complex disparities ecosystem to identify potential levers for change. System dynamics (SD) modeling employs a set of qualitative (causal diagrams) and quantitative (mathematical simulation models) methodologies for understanding complex systems from an endogenous feedback perspective, where the dynamic behavior of a system is explained by the system's internal structure [21–23]. Briefly, a complex system in SD is represented as a set of feedback loops which interact to produce nonlinear, dynamic behavior. The main goals of SD are (1) understanding the multifactorial causes of dynamic behaviors; (2) identifying leverage points in the system where interventions could be implemented to change system behavior; and (3) characterizing potential unintended consequences of interventions and determinants of policy resistance [21–23].

Inherent to SD is the understanding that factors and players across multiple sectors are involved in driving the system. As such, engaging multisectoral entities is necessary to fully capture the relevant system components and develop targeted, responsive interventions. Community-based participatory research (CBPR) offers a framework for engaging with communities and relevant parties to explore socioecological determinants of salient health issues, and identify feasible, acceptable interventions [24, 25]. For this reason, community engagement and SD are suggested as complementary approaches: by engaging partners in both the exploration of dynamically complex problems *and* model building, interventions are more likely to be effective, sustainable, and grounded in the local context [19]. Group model building (GMB) combines community engagement with SD; it is an innovative, participatory approach for developing SD models that actively engages community partners to explore the complex systems that govern and influence health disparities [26–28]. GMB can be an effective tool for understanding complex, multilevel systems that impact community health via community-driven input while also cultivating a framework of engagement between community members and decision makers using systems thinking [26].

Despite its orientation towards action, participatory systems science approaches have rarely resulted in (or reported on) *collective actions* [18]. Therefore, the extent to which SD can strengthen community engagement and yield actionable findings remains to be demonstrated. In this paper, we describe the use of GMB to better understand the multifactorial nature of food systems and nutrition disparities, map feedback processes that impact the health of local immigrant communities, and reflect on processes that could be leveraged to improve immigrant health. The broad theme guiding the GMB process was "nutrition and food programming for immigrant communities." We will summarize the GMB workshops and resulting causal loop diagrams (CLDs); describe cross-cutting themes and collective action ideas that emerged from the GMB workshops; and report participant evaluation of the GMB workshops. We also discuss preliminary impact of participatory GMB on the strength of community partnerships as an exemplar of how systems science can be used to deepen Community Outreach and Engagement (COE) initiatives by the National Cancer Institute (NCI) and other National Institutes of Health (NIH) Institutes and Centers.

Methods

FORTIFY project overview

The Focus on Obesity Reduction and Tools for Immigrant Families and Youth (FORTIFY) project was funded as a COE Administrative Supplement (Award 3P30CA016087) at the New York University (NYU) Perlmutter Cancer Center (PCC), which serves foreign-born and racially and ethnically diverse patient populations. The goals of the COE supplement were to elucidate best practices in participatory approaches for engaging community partners and patient populations to develop, adapt, implement, and evaluate existing evidence-based interventions (EBI). FORTIFY leverages Stamp Out Cancer Brooklyn, a community-engaged collaborative whose mission is to reduce cancer burden and cancer-related disparities in Brooklyn, New York and includes PCC, local community-based partners, the American Cancer Society, and NYU affiliates. Specifically, FORTIFY aims to integrate systems science in community-engaged collaborations to address systems level issues around food hardships and access during the COVID-19 pandemic. The supplement aims to foster ethnic pride and community healing through a celebration of identity and culture through traditional food, as a counter narrative to the heightened anti-immigrant sentiments.

Research setting and participant recruitment

In collaboration with FORTIFY partners in NYC, this project aims to identify system levers for food and nutrition interventions for sustaining healthy lifestyle behaviors and fostering ethnic pride and community healing among immigrant communities. Participant recruitment leveraged the existing, multisector FORTIFY network and PCC community advisory board. Participants comprised representatives from academia and six community-based organizations, three farming/gardening organizations, one academic-affiliated food pantry organization, two health advocacy organizations, and one local health department. Each workshop included up to two self-elected representatives from each participating organization, who were interested in or currently engaged in food and nutrition programs for immigrant populations in NYC; the majority of participants included organizational leadership and staff who had relevant expertise to the workshop topics. The subsequent plenary session included GMB participants and individuals from academia, community, and policy sectors who were recommended by GMB participants and accepted invitations to participate in the plenary session.

Informed consent was obtained from participants prior to the start of the workshops. Participants were provided a $175 incentive for each session (in-person workshop and virtual plenary) they attended. We considered their participation to be a considerable time commitment which included active engagement in GMB workshop discussions, commute time for in-person workshops, and managing competing organizational demands during an ongoing pandemic. Thus, in line with principles of health equity that guided our community engagement approach, we set an incentive amount that we felt would compensate our partners fairly for their participation and important contributions to this project.

Workshop design and modeling exercises

We conducted five sessions between October 2021 and January 2022 that included four in-person GMB workshops and one plenary session. Each session lasted approximately 3 hours. The four GMB workshops were grouped by partner interests and scope of work and centered on four pre-determined topics informed by each partners current programming: (1) community gardening, (2) nutrition education, (3) food assistance programs, and (4) community-supported agriculture. Three workshops (workshops #1, 2, and 4) engaged partners from academia, community-based organizations, farming/gardening organizations, academic-affiliated food pantry organization who had existing programs at varying stages of development; all workshop participants were professionally acquainted and had preexisting relationships with each other. The third workshop (workshop #3) engaged participants from community-based organizations in discussions around development and implementation of *future* food assistance programs; participants in this workshop had limited or no preexisting relationships with each other. No obvious power dynamics existed between workshop participants.

The workshops were led by three research team facilitators (SY, PC, NS) with experience in community-engaged research, implementation science, and GMB facilitation, two SD modelers (NS, RT), and at least two notetakers. Each workshop engaged participants in a free-flowing discussion informed by three guiding prompts around (1) programmatic goals, (2) anticipated challenges, and (3) potential mitigating solutions. The workshop goals were collaboratively agreed upon by participants at the beginning of each workshop, followed by regular check-ins with participants to integrate their priorities (to the extent possible) into the plenary session or related programming. The modeling exercises generated a CLD, a visual presentation of hypothesized causal relationships between variables and feedback structures within a system. The resulting CLD from each workshop was gleaned from participant discussions in real-time and were produced using Vensim DSS modeling software [29].

CLDs are made up of a core set of building blocks: variables, arrow linkages, and feedback loops, which can be connected to form more complex system structures [23] (Supplementary Fig. 1). Arrow linkages between variables represent hypothesized causal relationships. A positive (+) linkage indicates a change in the first variable produces a change in the same direction of the variable that follows. For example, increased access to healthy foods leads to increased diet quality (Fig. S1a), and conversely, decreased access to healthy foods leads to decreased diet quality. Negative (−) linkages indicate a change in the first variable produces a change in the opposite direction of the variable that follows. Increased food costs lead to decreased access to healthy foods (Fig. S1b), and decreased food costs lead to increased access to healthy foods. For some variables, the effect on the variable that follows happens with some time delay, as depicted by hash marks intersecting an arrow linkage (Fig. S1c).

A feedback loop is represented by a closed series of arrow linkages which can produce either reinforcing or balancing effects on system behavior. A reinforcing feedback loop contains an even number of (or zero) negative linkages and tends to accelerate the effects of disruptions to the system by leading to exponential growth or exponential decline of variables. Reinforcing loops can produce favorable outcomes (e.g., an increase in access to healthy food increases consumption of and demand for healthy foods, which increases

supply and access) (Fig. S1d) or unfavorable outcomes (e.g., a decrease in access to healthy food decreases consumption of and demand for healthy foods, further lowering supply and access). A balancing loop contains an odd number of negative linkages and tends to stabilize the effects of disruptions to the system, bringing variables into steady states. For example, an increase in government funds for nutrition programs that increase access to healthy foods may lead to healthier eating and a decline in diet-related disease. When diet-related disease rates are low, funding may also decline due to lack of perceived need for nutrition programs (Fig. S1e).

Each workshop resulted in a CLD that was validated by participants during a report back presentation during the second half of the workshop. This presentation included a mini lesson on systems thinking, how to interpret CLDs (Supplementary Presentation 1), and overview and example demonstrations of the workshop CLD produced. CLDs were digitally projected and refined in real time in response to participant feedback to further encourage strategic and collective systems thinking. We collectively examined each loop to ensure the CLDs matched participants' conceptualization of the problem. Participants' feedback included recommendations for nuancing the wording of variables, adding or deleting variables, and adjusting the linkages between variables. After the workshop, CLDs were further refined according participant feedback, in-depth review of workshop notes, and photographs taken during the sessions of whiteboard and paper drawings created by the research team and participants, and iterative discussions among the research team. The four CLDs were synthesized to draw connections between the mental models explicated during individual GMB workshops and identify shared challenges and opportunities for collective action.

The virtual plenary session was a culmination of cross-cutting insights from the four GMB workshops and included an overview of each workshop, introduction to systems thinking concepts and CLD interpretation, workshop outcomes, and recommendations for collection action. The plenary also included breakout sessions for further discussion about each action area. The plenary included GMB workshop participants and participants from academia, health advocacy organizations, and the health department. This study was determined to be exempt by the NYU Grossman School of Medicine Institutional Review Board.

Partnership evaluation

We administered an online evaluation survey at baseline and after the GMB workshops. The evaluation survey was informed by VanDevanter et al. and Zimmerman et al. [30, 31] and included 17 items about general satisfaction, impact, trust, decision making, organization and structure of meetings, and knowledge of systems thinking. All responses were on a 5-point Likert scale with choices ranging from 1 (strongly agree) to 5 (strongly disagree) (i.e., lower scores indicate better agreement). The follow-up survey included the questions from the baseline survey, three questions on satisfaction with GMB activities, and one open-text question to capture general feedback.

We calculated mean scores to describe and compare participant responses between baseline and follow-up. A lower mean score represents greater agreement with a question or domain. Analysis of survey data was conducted using R (version 4.2.2) [32].

Results

Below, we present CLDs from the four GMB workshops (n = 11), themes and collective action items from the plenary session, and the partnership evaluation results.

Workshop 1: Community gardening

The first GMB workshop (n = 4) centered on implementation challenges and potential impacts of nutrition education within the broader food policy landscape. Figure 1a shows the CLD created that contains three balancing loops and four reinforcing loops centered on the provision of nutrition education within socially and economically underserved immigrant communities in NYC. Supplementary Table 1 has detailed descriptions of all CLD feedback loops.

Figure 1b highlights a balancing feedback loop (B1) that was identified during this session. This loop shows how diet-related disparities might exacerbate health disparities in the community and worsen health disparities experienced by the community. This might lead to greater prioritization of nutrition education and increased demand for culturally appropriate nutrition education. Increased demand for culturally appropriate nutrition education could initiate provision of nutrition education programs that address community needs that then reduces diet-related and health disparities in the community. The B1 feedback loop emphasizes that prioritization and investment in culturally appropriate nutrition education could decrease diet-related and health disparities in immigrant communities; promotion of culturally appropriate nutrition education must be constant in order to avoid de-prioritization.

Workshop 2: Nutrition education

The second GMB session (n = 6) focused on preserving culture through food and building cross-cultural interactions and relationships. Figure 2a shows the resulting CLD that has four reinforcing feedback loops. These reinforcing loops emphasize that preserving traditions and cultural food knowledge and practices may also impact nutrition education promoting healthier eating behaviors, cultural identity, and overall well-being.

Figure 2b highlights two interacting reinforcing loops (R1 and R2) that demonstrate how maintaining traditional cultural practices preserves culture and reinforces cultural identity through the dissemination of community knowledge of traditional food practices which empowers people to eat healthy food from their own cultures. The R1 reinforcing loop shows that community knowledge of traditional cultural food practices may lead to more nutrition education through dissemination of traditional nutritional knowledge that motivates individuals to eat healthy foods from their culture and strengthens their culture identity, thus, preserving Culture through food rituals and increasing community knowledge of traditional food practices. The R2 reinforcing loop shows that cultural identity is reinforced by and reinforces preservation of culture through food rituals.

Potential challenges discussed for implementation of culturally appropriate produce as local growers meet consumer demand for culturally appropriate produce; increased supply then increases community access to culturally appropriate produce in their neighborhoods.

Workshop 3: Food assistance programs

The third GMB workshop ($n = 2$) was an exploratory session focused on challenges in implementing community-engaged food assistance programming to address food insecurity, overall well-being, and healthy aging in communities of color. Figure 3a shows the four balancing and three reinforcing loops identified that highlighted challenges and opportunities for facilitating community access to healthy and culturally sensitive ethnic foods.

Figure 3b shows the B2 balancing feedback loop and R3 reinforcing feedback loop demonstrating competing challenges in designing nutrition programs that facilitate access to healthy and culturally sensitive ethnic foods for immigrant and other marginalized (e.g., low-income) populations. The B2 balancing feedback loop shows that the lack of access to ethnic foods through nutrition programs like food pantries, leads to an increase food waste or leftover unfamiliar food products at food pantries, which drives the need for nutrition programs to devise creative strategies to prevent waste and use leftovers. For example, creating and sharing ethnic recipes that incorporate unfamiliar food products from nutrition programs would increase knowledge of program staff and policymakers about the food preferences of their program beneficiaries and could lead to program adaptations or food products that better align with community preferences and increase access to culturally relevant, healthy foods.

The R3 reinforcing feedback loop reveals a competing reinforcing process which may be an unintended consequence of adapting food offerings provided through nutrition programs. When communities can utilize non-ethnic food from pantries which would otherwise be wasted, nutrition programs are disincentivized to source and offer culturally sensitive foods which further reduces access to healthy, culturally relevant ethnic foods to program beneficiaries.

Workshop 4: Community–supported agriculture

The fourth GMB workshop ($n = 5$) revealed that community-centered nutrition interventions that provide culturally appropriate produce could create a sustainable market for local growers to increase supply of, and access to locally grown, culturally appropriate produce. This in turn could promote well-being among at-risk immigrant communities in NYC.

Two example loops from the full CLD are highlighted in Fig. 4b. The R1 reinforcing loop demonstrates how increased demand for culturally appropriate produce can lead to increased supply of locally grown, culturally appropriate produce as local growers attempt to meet local consumer demand. This increase in supply can promote increased access to culturally appropriate produce grown locally. When individuals have access to and begin using fresh, healthy produce from their culture, this can improve happiness and well-being through connection to culture and healthy eating, which motivates a demand for fresh, locally grown, culturally appropriate produce.

The B1 balancing loop highlights an unintended consequence of increased supply and access to locally grown, culturally appropriate produce. Increasing community access to culturally appropriate produce by local growers could decrease food waste in nutrition programming

that tailors produce offerings to preferences of the communities they serve. When less food is wasted from these nutrition programs, there is less motivation for community activation and engagement to address the problem of food waste or related challenges associated with effective implementation of nutrition programming. Lower community engagement results in lower demand for culturally appropriate produce, which decreases the supply of and access to it.

Considerations discussed to develop a sustainable market for culturally appropriate produce among local growers included target pricing and affordability of local produce (e.g., supporting local growers to scale up production of culturally appropriate produce or providing community linkages to public benefits programs like SNAP benefits); sustaining community engagement in nutrition education programs; and encouraging immigrant communities to purchase locally grown produce and local growers to increase supply of culturally appropriate produce.

Plenary collective action

The GMB discussions yielded the common goal to embed cultural tailoring at every level of the food system to improve food and nutrition programming for immigrant communities. Four cross-cutting themes and action items are detailed below (Table 1).

Action theme #1 is to provide culturally tailored community-based nutrition education. Combining the health education expertise of the academic team with the local knowledge and community reach of community organizations was suggested as a mechanism to develop and disseminate culturally tailored nutrition education to community member, to preserve culture and foster a sense of community through traditional food practices. Some partners proposed incorporating education on unfamiliar foods and produce to increase utilization of existing produce in the community and reduce food waste.

Action theme #2 is to facilitate communities' access to culturally appropriate produce. While education can increase awareness of and pride in traditional foods, the availability of culturally appropriate produce remains a challenge. Partners suggested developing a community-supported agriculture model in partnership with community organizations, to engage community members in the selection of crop plans and create a consumer base for culturally appropriate produce.

Action theme #3 is to foster pride in immigrant identity through food. To counter the racist anti-immigration rhetoric prevalent during and after COVID-19, participants suggested utilizing community gardens as avenues for experiential learning opportunities to grow and learn about culturally appropriate produce. This in turn could reduce stigma related to eating traditional foods by creating a sense of belonging to a shared identity.

Action theme #4 is to enact inclusive local and federal food policies. Food and nutrition guidelines tend to draw from dietary habits of White Americans, which can limit the availability of culturally tailored nutrition education resources and restrict the types of foods provided in food assistance programs. Participants that offered emergency food assistance to immigrant communities during COVID-19 bemoaned the lack of culturally tailored food

items included in the boxes provided to their clients. Clients were unfamiliar with certain items and did not know how to prepare them, leading to food waste at a time of heightened food insecurity.

Partner evaluation

The baseline survey was completed by all workshop participants ($n = 11$) and the follow-up survey by 9 of 11 participants (Table 2). Overall, mean scores improved between baseline and follow-up across the domains of partnership satisfaction, impact, trust, ownership, and organization. At follow-up, participants reported an increased understanding of systems thinking (baseline: Mean = 3.82; follow-up: Mean = 2.22). Most participants ($n = 6$) found the GMB workshops to be 'somewhat useful' and 'very' to 'somewhat' convenient ($n = 7$) to participate in the workshops.

Open-ended comments were generally positive; some participants reported the complex models challenging to understand and one participant questioned how models can translate into tangible action. Notable comments included: "*It was helpful to see the systems work in action. It does take some time to process the information, but overall, I believe this work will benefit our community members when thinking about the barriers and enablers to long-term health outcomes and policy change*"; "*It was my first time being in a room with these groups. It was good to hear about different groups' work, and start to feel out how we may be able to work together and/or support each other's work*"; and "*Valid model but unclear whether its use will translate to anything tangible*."

Discussion

We described a participatory SD approach to characterize barriers and opportunities for nutrition programming for immigrant communities in NYC. The GMB workshop discussions and CLDs had overlapping and unexpected insights to improve nutrition and food programming for immigrant communities. Common themes included: (1) the role of nutrition education in reducing health disparities and the need for sustained education efforts to maintain community engagement and interest; (2) the preservation of culture and promotion of well-being through traditional food knowledge and practices; (3) the need for inclusive food policy that integrates ethnic foods in nutrition guidelines and education, and further downstream in food assistance programs; and (4) the value to promote and maintain demand for locally produced ethnic produce through partnerships between growers and communities. The overarching goal was to embed culture in the food and nutrition space at the outset, to avoid exclusionary practices towards the food practices of immigrant and minoritized communities and the need for community-led adaptations.

Themes generated through the GMB workshops align with the broader literature on cultural tailoring. Extensive evidence supports culturally tailoring community-based nutrition education for chronic disease prevention and management among minoritized and immigrant communities [33, 34]. Similar to our findings on preserving culture, prior research on cultural tailoring often involves incorporating traditional foods and cultural values (e.g., family, community connectedness) and the delivery of interventions by linguistically and culturally congruent facilitators in community settings [35, 36]. The burden of food

insecurity, increase in utilization of emergency assistance like food pantries, including use among SNAP beneficiaries, and food assistance challenges during the COVID-19 pandemic for minoritized communities [37, 38] were emphasized during the GMB workshops. While studies have reported on the challenges of accessing *healthy* foods in pantries [39], few studies have explored the cultural appropriateness of food assistance. For example, one study revealed Native Hawaiian/Pacific Islander community members were sharing the *types* of foods and which culturally relevant foods were being offered by local food assistance programs during COVID-19 pandemic on Facebook [40]. Our findings underscore that culturally tailored food assistance programs should be prioritized for urban immigrant communities to achieve equitable emergency responses during the pandemic. This approach would not only respond to community needs and promote food security, it will also prevent food waste. The cultural mismatch between communities and food assistance programs and policies emphasize the one-size-fits-all approach in food programming, which does not align with the diversity and dietary preferences of communities served. Through GMB workshops, we found that a multisectoral partnership model between communities, growers, and academia can generate a sustainable supply of culturally appropriate produce. This model aligns with calls to de-centralize the food supply and support community-driven alternatives (e.g., farmers markets, community gardens) that can better meet the needs of local populations [41, 42].

Main findings from GMB workshops

GMB discussions provided a deeper understanding of the complex factors that shape community-based nutrition programming and community wellbeing, including during the COVID-19 pandemic. Participants were involved in existing nutrition-related programs at various stages of development and had different degrees of professional acquaintance and preexisting collaborations with one another. Workshops that included participants with preexisting relationships were less exploratory and prompted discussions that focused on existing programming and tangible action steps at the individuals, food/growing, and policymaking levels.

The redesign of the workshops allowed us to better accommodate participants' needs. For example, the length of workshops were shorter and not held on consecutive days due to competing demands of community organizations; more time was allocated for sharing concrete examples from the CLD models versus reviewing the theoretical implications of the CLDs in order to prioritize collective action; and GMB workshops discussions were pivoted to identify goals informed by pandemic experiences.

The GMB workshops and plenary session occurred between the Delta and Omicron waves of the COVID-19 pandemic. Having these sessions during an ongoing public health emergency may have generated greater motivation from participants to maximize their time during the workshops and identify interacting factors to respond to community needs. The opportunity to meet in-person after an extended period of virtual engagement created fertile grounds for collective thinking around mutually reinforcing strategies to promote immigrant health across a diverse set of community partners. The multiple pressures and urgency experienced during the COVID-19 pandemic by participants could have heightened their

attention towards drivers of food insecurity and the modifiable systems' levers that could promote healthy lifestyle behaviors and community healing. Some partnering organizations provided emergency food assistance to their communities during the pandemic that provided culturally relevant food products, COVID-19 related education and supplies, and increased sense of community support despite the stay-at-home orders. Thus, these experiences and emergent community needs may have informed their prioritization of culturally tailored food assistance policies in the CLDs.

Participants were less interested in the theoretical implications of GMB and SD and more focused on the practical uses of the CLD models that could benefit community members in the immediate and long term. Therefore, the discussions were action-oriented and combined knowledge gained from the CLD models with participants' organizational experiences to strategize around tangible strategies to address shared challenges.

Grounding GMB and SD in CBPR can deliver systems models as well as opportunities for collective action [19, 24]; in other words, GMB and SD are community-driven processes that can can be leveraged in tandem to inform community-engaged interventions that address multilevel community-identified priorities. This combined approach can be an exemplar to deepen NCI and NIH COE initiatives; however, we encourage public health professionals to regularly evaluate the intended outcomes of systems sciences and how community partners are being engaged. Community engagement initiatives must be mutually beneficial and reciprocal (e.g., community partners are involved in more than an advisory capacity and involved in the co-creation of the final products), and research must particularly be beneficial for priority communities. Academic partners can serve as the conveners of systems science processes (e.g., organize GMB workshops) and provide expertise on SD and GMB processes; community partners can provide knowledge of the local context and identify intervention levers based on CLDs. Together, academic and community partners can identify, tailor, and implement evidence-based strategies to advance cancer equity that are steeped in the local context.

Partner engagement and GMB perceptions

Engaging in the GMB process strengthened FORTIFY community-academic partnerships and is a promising tool for community engagement. GMB participation increased participants' knowledge of systems thinking, indicating a potential for capacity building among community partners around a novel research area. The workshops were structured to include an introduction to the GMB process and an overview of sample CLD models to ensure participants can engage fully with the modeling exercises. However, one participant noted that the models were challenging to grasp and operationalize, emphasizing the importance of introductory training on CLDs. Some participants appreciated the opportunity to engage with new organizations and learn about their work. GMB has a benefit of convening multisectoral participants to identify the complex systems that impact health and levers within a system where an intervention or policy might change how the system interacts to impact health.

The GMB process was effective in building a community of practice by convening diverse groups who identified community-driven priorities and collective recommendations that

aligned with principles of authentic community engagement and CBPR. For example, together with participants, we are applying the knowledge gained from this project to an expanded, community-partnered initiative for Bangladeshi, Chinese, and Mexican communities that provides culturally appropriate produce from farms, in-language and culturally appropriate nutrition education, and gardening experiential learning. The action ideas were beyond what individual organizations could achieve, and rather leveraged collective knowledge, experiences, and resources for sustainable community impact and activation to promote inclusive food environments for immigrant communities.

Strengths and limitations

Major strengths of this project include the project pivots in response to community concerns and the COVID-19 pandemic to ensure community voices remain central to the GMB approach. Broadening FORTIFY's focus from identifying feasible and sustainable ways to improve lifestyle behaviors among Mexican and Chinese communities in Brooklyn to identifying community-based programs and policies to foster community healing through food allowed for greater motivation to engage in GMB workshops and alignment with community partner priorities. Thus, the key leverage points in the system highlighted could have consequential and lasting benefits for immigrant communities and their families because participants were actively engaged in ongoing support for their community members in response to the COVID-19 pandemic, in addition to their organization's regular services and job roles. The CLDs presented are reflective of the diverse perspectives of the FORTIFY network, who are engaged in multiple settings of food programming in NYC. The systems thinking domain of the evaluation were positive, showing that participants perceived improved understanding of SD modeling concepts and the utility of SD modeling and systems thinking to generate community action and inform decision making around nutrition programming.

There are some limitations to note. Due to COVID-19 restrictions related to in-person programming, there was limited time allocated with participants to validate the CLDs created. Unlike typical GMB models that may engage participants in longer sessions to develop and digest CLDs, the CLDs presented were refined by participants during each specific workshop only and refined by the study team post-workshop. The CLDs presented are exploratory and require further refinement and validation from partners before developing formal quantitative models and simulation. The recommended actions presented may not have encompassed concerns of all participants and misaligned with partner priorities; however, participants were provided ongoing opportunities to continue discussions and partner with one another.

Conclusion

We propose GMB as a novel community engagement approach with partners representing local communities from the cancer center catchment area. The project elucidated the dynamic system that influences food and nutrition programming for immigrant communities and identified opportunities for collective action, ranging from community-based nutrition education to policy advocacy. Findings from the study have and will continue to inform

partnered interventions to advance the wellbeing—with a focus on food and nutrition—of immigrant communities in the catchment area of the NYU PCC.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Data availability

The datasets generated during and/or analyzed during the current study are not publicly available due to privacy/ethnic restrictions.

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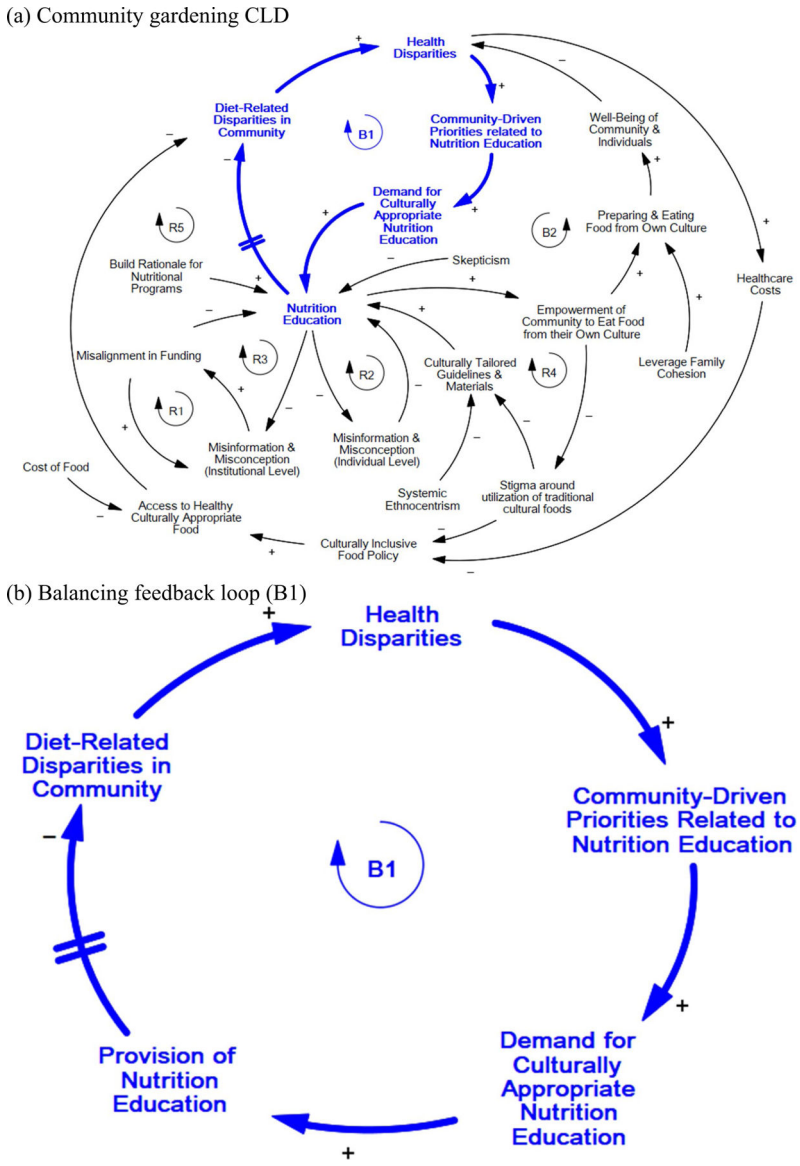
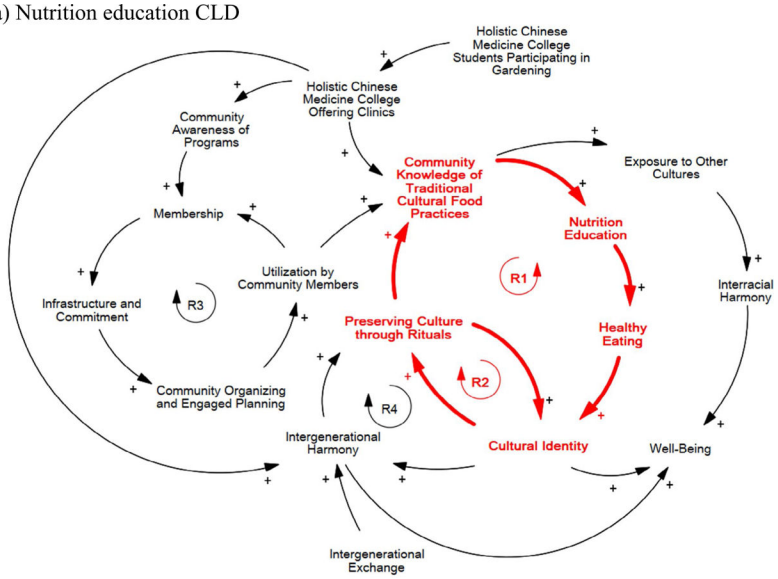


Fig. 1.

Causal Loop Diagram (CLD) for community gardening (Workshop #1)

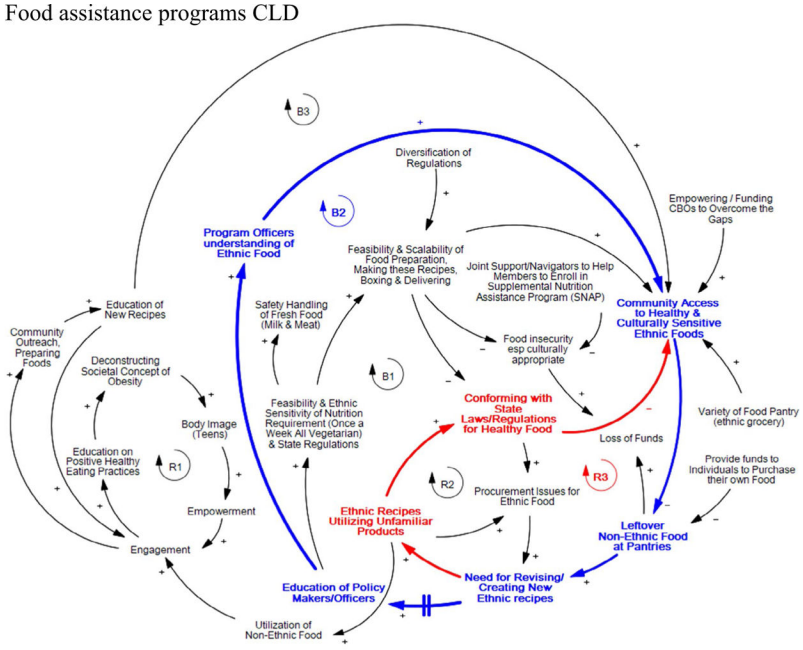
(a) Nutrition education CLD



(b) Reinforcing feedback loops (R1 & R2)

Fig. 2.
Causal Loop Diagram (CLD) for nutrition education (Workshop #2)

(a) Food assistance programs CLD



(b) Balancing feedback loop B2 & reinforcing feedback loop R3

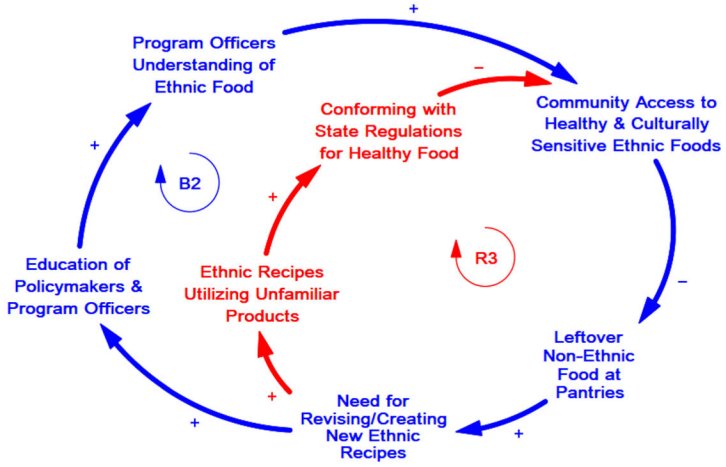
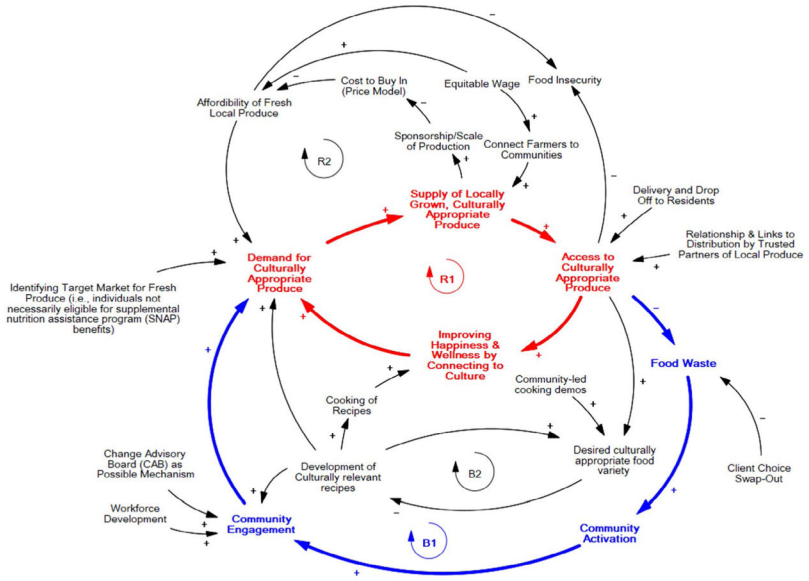


Fig. 3.

Causal Loop Diagram (CLD) for food assistance programs (Workshop #3)

(a) Community-supported agriculture CLD



(b) Balancing feedback loop B1 and reinforcing feedback loop R1

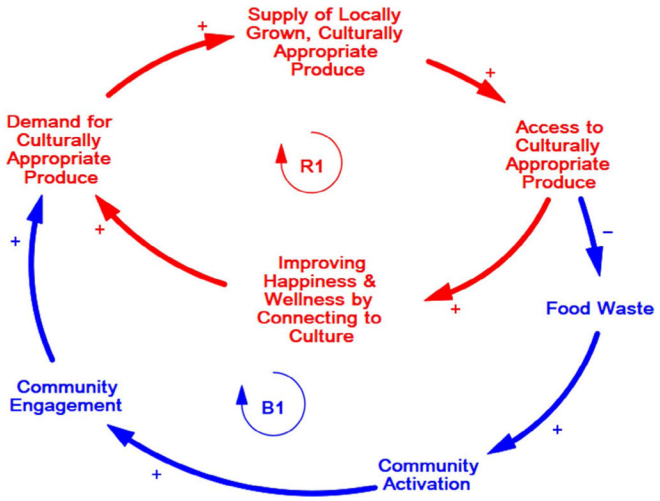


Fig. 4.

Causal Loop Diagram (CLD) for community-supported agriculture (Workshop #4)

Table 1

Cross-cutting GMB workshop themes and community action items

	Cross-cutting GMB workshop themes			
	Provide community-based nutrition education	**Facilitate access to culturally appropriate produce**	**Foster pride in cultural and immigrant identity**	**Enact inclusive food policy**
Workshop 1: Community gardening	Culturally tailor nutrition education and curricula to include traditional foods and recipes	Increase availability of culturally appropriate produce	Foster cultural pride and immigrant identity through experiential learning opportunities in community gardens Reduce stigma related to eating traditional foods	
Workshop 2: Nutrition education	Preserve culture through traditional nutrition knowledge and practices	Incorporate traditional food examples and recipes in nutrition education materials to promote uptake of culturally appropriate produce	Preserve culture by integrating traditional foods and recipes in nutrition education materials Build and strengthen cross-cultural ties in the community	Increase the availability of linguistically and culturally tailored nutrition education materials
Workshop 3: Food assistance programs	Provide nutrition education for unfamiliar produce and foods to reduce food waste	Connect with farms/farmers markets/ grocery stores that can donate culturally tailored foods	Assess community members' food preferences to inform food offerings Provide traditional recipes with food assistance boxes	Support community organizations facilitating SNAP enrollment Culturally tailor food assistance offerings to recipients Decentralize food procurement; give community organizations authority to purchase culturally tailored foods
Workshop 4: Community-supported agriculture	Provide nutrition education for unfamiliar produce and foods to promote uptake of harvest and reduce food waste	Increase and sustain supply of traditional produce Ensure produce affordability at multiple levels (for individuals, local growers, produce sellers)	Create/increase consumer demand for culturally appropriate produce	

Cancer Causes Control. Author manuscript; available in PMC 2024 March 29.

Table 2

Partnership evaluation surveys, at baseline (n = 11) and follow-up (n = 9)

	Baseline Mean (SD)	Follow-up Mean (SD)
General satisfaction		
I am generally satisfied with our partnership with the NYU Section for Health Equity	1.73 (1.01)	1.33 (0.71)
I am satisfied with the priorities being addressed through my organization's partnership with the NYU Section for Health Equity	1.73 (1.01)	1.44 (1.01)
I frequently think of having my organization sever its affiliation with the NYU Section for Health Equity	3.55 (1.57)	4.56 (1.01)
Our partnership has been effective in achieving its goals	2.55 (0.69)	1.89 (0.93)
Impact		
Participating in our partnership has increased my knowledge and understanding of the other organizations working with the NYU Section for Health Equity (e.g., other organizations involved with Stamp Out Cancer Brooklyn or these workshops)	2.36 (0.92)	1.67 (0.87)
Participation in our partnership has increased my organization's capacity to conduct research	2.64 (1.03)	2.44 (0.88)
My organization uses knowledge generated by our partnership's project(s)	1.91 (0.94)	1.67 (0.71)
Trust		
I feel comfortable talking openly and honestly at our partnership meetings	1.73 (0.90)	1.44 (0.73)
I am comfortable bringing new ideas to our partnership meetings	1.73 (0.90)	1.44 (0.73)
Partnership members respect each other's points of view even if they might disagree	1.73 (.90)	1.11 (.33)
Decision making		
All partnership members have a voice in decisions made by the group	1.91 (1.04)	1.33 (0.50)
It often takes our partnership too long to reach a decision. radio, Required	2.64 (0.67)	3.22 (0.83)
Organization and structure of meetings		
I find partnership meetings useful	1.91 (0.94)	1.67 (1.00)
Partnership meetings are too frequent	3.36 (0.67)	3.67 (1.00)
Partnership meetings are well organized	2.09 (0.94)	1.11 (0.33)
Systems thinking		
At the present time, your understanding of the components of system dynamics models (e.g., feedback loop, stocks & flows) is:	3.82 (1.07)	2.89 (1.05)
The potential of modeling to inform decision-making or to improve decision making (as compared to decision making without modeling) is:	2.91 (0.83)	2.22 (0.97)
Overall satisfaction		
How useful were the Group Model Building activities to your organization?	–	2.33 (0.50)
How convenient was it to participate in Group Model Building meetings?	–	1.88 (0.78)

A lower mean represents greater agreement with the statement under each domain. The means are based on a Likert scale where '1' is strongly agree, '2' is agree, '3' is neutral, '4' is disagree, and '5' is disagree. Overall satisfaction was only assessed at follow-up