Beyond the Intervention: Mapping the Feedback Dynamics That Shape Dietary Behavior Following a Produce Prescription Program in Rural Mississippi

ABSTRACT

Introduction: Despite growing investment in Food is Medicine (FIM), knowledge gaps remain in understanding the sustainability of dietary behavior change following intervention completion. This study leverages insights from semi-structured interviews conducted with Delta GREENS produce prescription (PRx) randomized controlled trial (RCT) participants at program completion (12 months) and three months post-program (15 months) to develop a causal loop diagram (CLD) examining the feedback mechanisms influencing post-program fruit and vegetable (F&V) intake sustainability. **Approach:** We use an interview-based mental model elicitation approach to identify key variables, causal relationships, and emergent feedback loops from participant narratives at 12 months (n=20) and 15 months (n=15 of 20 to date). Themes from post-program interviews iteratively inform CLD development, and broader environmental factors, including food cost, household income, and fresh F&V retail access, are treated as exogenous contextual drivers. **Results:** The preliminary CLD identifies seven feedback loops - two reinforcing and five balancing - shaping post-program F&V intake. Erosion dynamics outweigh sustaining forces, driven by the weakening of fresh F&V routines, convenience-driven substitution, and budget-driven shifts toward lower cost processed foods, interacting with structural constraints in the food environment. **Discussion:** These compounding feedback dynamics, temporarily buffered by the produce prescription program, shape post-program F&V intake sustainability. Post-program fresh F&V access, affordability supports and cooking routine maintenance emerge as potential leverage points. The finalized CLD will provide a foundation for future simulation modeling to evaluate and prioritize leverage points that support sustained dietary behavior change.

Introduction

Food is Medicine (FIM) is a healthcare strategy encompassing a range of interventions that integrate nutritious food into disease prevention, management and treatment.[1,2] Among these interventions are produce prescription (PRx) programs, which enable healthcare providers to prescribe fresh fruit and vegetables (F&V) to patients.[3] These programs have gained significant policy and research momentum in recent years, with emerging data demonstrating the benefits of FIM interventions to improve food security, diet quality and health outcomes.[1,2,4] Yet,

knowledge gaps remain in understanding the sustainability of behavior change following program completion, specifically, how post-program results are maintained or eroded over time.

This study examines dietary F&V intake dynamics among intervention arm participants who have completed the Delta GREENS (Growing a Resilient, Enriching, Equitable, Nourishing Food System) FIM PRx Randomized Controlled Trial, a 12-month study during which intervention participants received a culturally tailored cookbook, access to cooking demonstration videos and monthly nutrition education classes, and fully subsidized weekly boxes of fresh produce valued at approximately $25. The participants were recruited from three rural counties in the Mississippi Delta, all of which experience high rates of food insecurity, [5–7] poverty [8–10] and limited full service grocer access.[11,12] Using a causal loop diagram (CLD), we explore the dynamic interplay between food affordability, time pressure, maintenance behaviors and cooking routines on fresh F&V consumption post-program (i.e., once participants are no longer receiving boxes of fresh produce).

Methods

Participants who completed semi-structured interviews at 3-and-6 months were re-recruited for interviews at 12 months (N=20) and 15 months (N=15, Target N=20), all from the intervention arm. Using Social Cognitive Theory (SCT) as a guiding framework, interviews explore factors influencing sustained fresh F&V consumption post-program. SCT was selected a priori and applied longitudinally to elucidate mechanisms of behavior change that persist, erode, or adapt both during and following program completion, guiding investigation of how cognitive, behavioral and environmental factors interact to shape dietary behavior through a process of reciprocal determinism, whereby each domain continuously shapes and is shaped by the others.[13]

We developed a CLD representing post-program dynamics through participant elicitation via iterative semi-structured interviews, drawing on the interview-based mental model mapping approach described by Kenzie et al.[14] Participants described household-level behavioral dynamics influencing F&V intake post-program. Themes from the 12-and-15-month interviews inform key variables, causal relationships, and emergent feedback loops. The CLD was built iteratively as interviews were conducted to display and analyze relationships and post interview notes were reviewed to further inform and clarify relationships. Broader environmental factors such as food cost, household income, and fresh F&V retail access surfaced during interviews and are treated as contextual exogenous drivers. Fast food restaurant density also emerged as a relevant contextual factor and will be examined in subsequent CLD iterations. Using Nvivo14, transcripts will be deductive by SCT domains and inductively to capture emergent themes. Inter-rater reliability will be established by double coding 26% of the transcripts. The CLD will be refined as additional qualitative coding and interviews are completed. It will be validated by community partners and study participants.

Results

The preliminary CLD suggests that post-program fruit and vegetable (F&V) intake is shaped by multiple feedback structures with erosion dynamics outweighing sustaining forces following program completion. Figure 1 depicts the reinforcing loop **Health Benefits Motivate Fresh F&V Intake (R1)**. Participants described program health benefits such as weight loss, and improved biomarkers, as motivation for continued efforts towards maintaining fresh F&V intake levels achieved during the program.

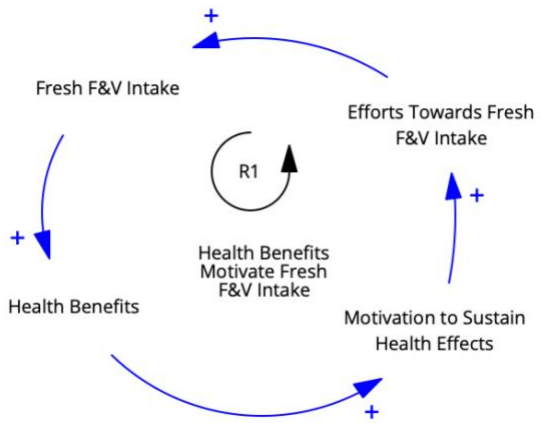

Figure 1: Health Benefits Motivate Fresh F&V Intake (R1)

Figure 2 depicts the balancing loop **Intake Maintenance Effort (B1).** Program completion created a gap between actual Fresh F&V intake post-program and the reference intake participants established during the study. Participants described intentional efforts to sustain fresh F&V intake levels achieved during the program. However, corrective efforts were constrained by various factors.

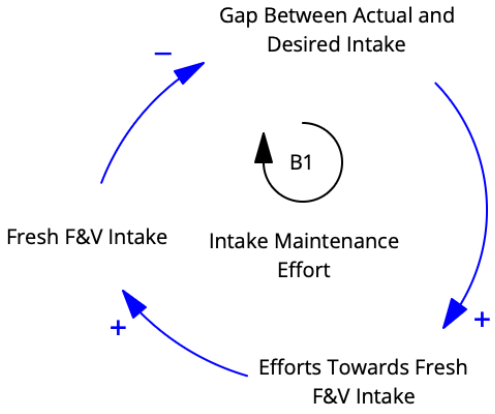

Figure 2: Intake Maintenance Effort (B1)

Figure 3 depicts the balancing loop **Goal Adjustment (B2)**. Participants described adjusting their desired intake goals to align with what was deemed achievable for their household given produce affordability, time pressure, and geographic accessibility challenges.

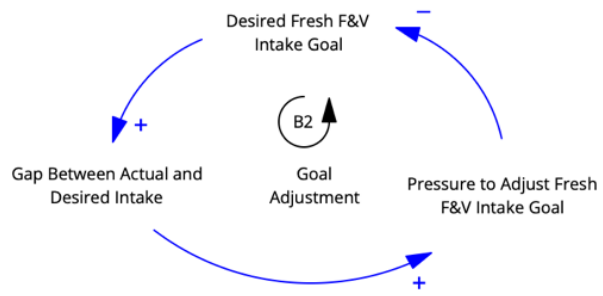

Figure 3: Goal Adjustment (B2)

Figure 4 depicts the balancing loop **High Price of Fresh F&V Coping Strategy (B3).** Removal of the subsidized produce box directly impacted household food budgets and their ability to meet food needs. Reverting to sole reliance on household income for food purchasing prompted participants to seek discount shopping strategies to maintain fresh F&V intake post-program. Many participants described relying on sales and coupons to offset fresh F&V costs and reduce budget strain.

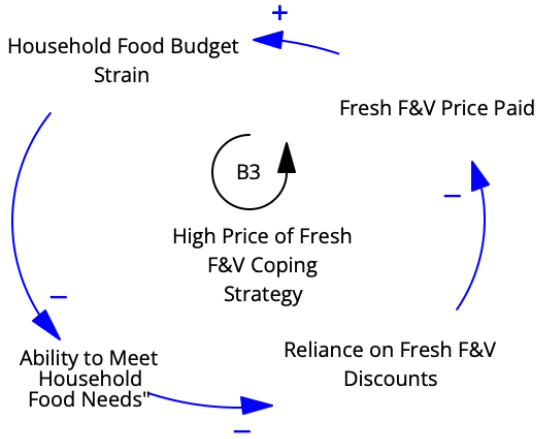

Figure 4: High Price of Fresh F&V Coping Strategy (B3)

Figure 5 depicts the balancing loop, **Fresh F&V Substitution (B4).** Removal of the subsidized produce box directly impacted household food budgets and their ability to meet food needs, resulting in adjustments to how participants sourced and purchased food. Many participants chose to substitute with lower cost processed alternatives, purchasing canned, frozen, and shelf stable food products.

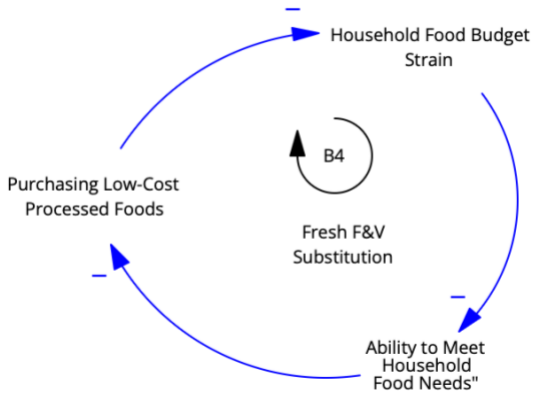

Figure 5: Fresh F&V Substitution (B4)

Figure 6 depicts the balancing loop, **Time Pressure Relief (B5)**. Removal of the produce box increased time demands associated with meal ideation, shopping, and produce quality evaluation, and selection. Participants described how this increased time burden, compounded by personal and familial obligations, drove the purchasing of convenient meal alternatives, temporarily relieving time pressure.

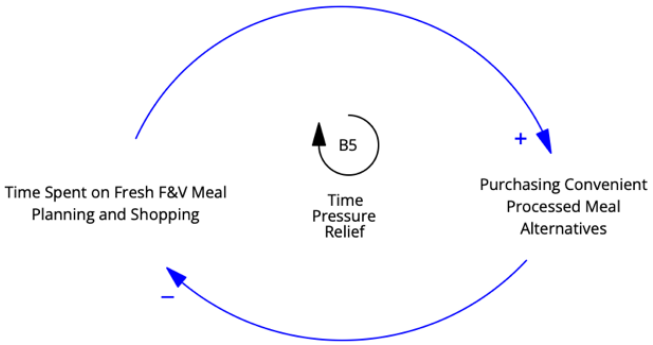

Figure 6: Time Pressure Relief (B5)

Figure 7 depicts the reinforcing loop, **Produce Routine Erosion (R2).** Removal of the produce box increased the time burden associated with fresh F&V meal planning and shopping, prompting convenience driven substitution that reduced cooking frequency. Decreased cooking frequency is theorized to gradually weaken household fresh F&V cooking routines over time - an unintended consequence of structural changes to the food environment - increasing the burden of fresh F&V meal preparation and further reinforcing the selection of convenient meal alternatives. This erosion is consistent with health psychology literature on habit formation, whereby a behavior paired with a stable context cue, such as the weekly produce box, and reinforced by repetition, such as repeated integration of fresh F&Vs into cooking routines, creates a behavior-context association that automatically triggers behavioral engagement with minimal cognitive effort - an association that weakens as the cue is removed and repetition declines.[15–17]

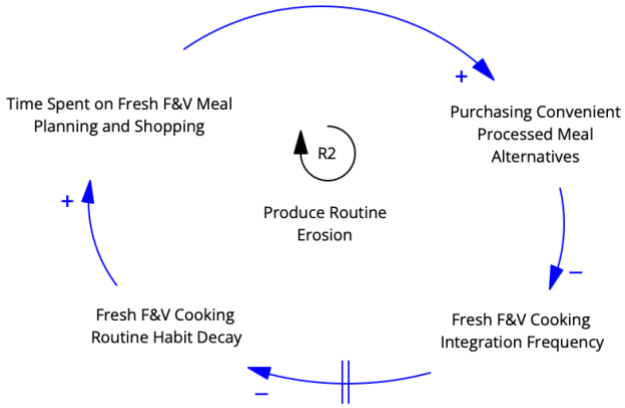

Figure 7: Produce Routine Erosion (R2)

Taken together, Figure 8 reveals how sustaining F&V intake post-program is shaped by the dynamic interplay between affordability, time pressure, environmental constraints and routine retention with multiple erosive dynamics challenging sustained dietary behavior change.

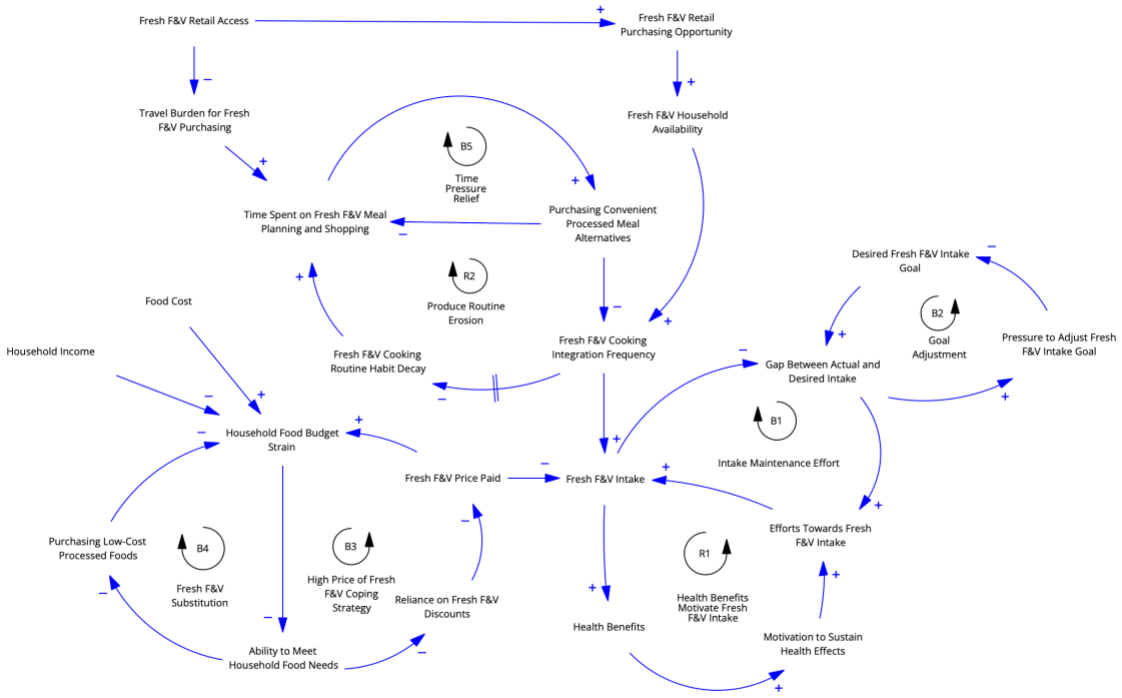

Figure 8: Causal Loop Diagram of Feedback Mechanisms and Exogenous Contextual Drivers Influencing Post-Program Fresh F&V Intake Sustainability Among Delta GREENS Intervention Participants

Discussion:

The 12-month produce prescription program strengthened cooking competency, supported meal planning routine development and temporarily buffered access and affordability constraints for participants in these three rural communities. Sustaining behavioral gains achieved during the produce prescription intervention without ongoing support presents compounding challenges as post-program dynamics appear driven by routine weakening (reduced produce intake and cooking frequency) interacting with short-term coping responses including convenience driven substitution and budget driven shifts toward lower cost processed foods. This underscores how post-program environmental shifts trigger cascading behavioral and cognitive responses, consistent with reciprocal determinism central to SCT. These preliminary dynamics suggest post-program fresh F&V access, affordability supports and cooking routine maintenance as potential leverage points. By clarifying the relationships among system variables and feedback structures, we are building a foundation on which future simulation modeling could evaluate and prioritize the leverage points that best support sustained dietary behavior change.

Our use of SD to analyze our qualitative interviews is an important contribution to the growing FIM field. Most FIM evaluations consider factors influencing program participation or outcomes during the intervention period, with limited focus on post-program sustainability or the dynamic feedback mechanisms that shape behavior following program completion.[18] Without considering the feedback structure of how program participants behave in the real world, we miss opportunities for strengthening advantageous dynamics and interrupting harmful ones. Understanding how these dynamics differ across food environments and FIM program types could provide insight into how structural contexts shape post-program sustainability and inform intervention design.

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