# Community Cooking Nights: An Agent-based Model for Promoting Healthy Eating and Social Cohesion

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**Abstract**

The current food practices in high-income countries are characterized by unhealthy and inequitable patterns that strain environmental resources. This study proposes a community-driven solution: a free cooking night utilizing rescued local fruits and vegetables to encourage healthier eating habits, promote local produce, and enhance social connectivity. Using an agent-based model, the study investigates the factors influencing participation in such initiatives and their impact on eating habits and social cohesion. The model operates over a 20-week timeline, evaluating the effects of weekly cooking nights on residents' health and social engagement. Simulation findings indicate that community cooking nights can effectively promote healthier dietary habits, increase social connections, and potentially lead to weight management improvements.

## Introduction

The current food practices in high-income countries are characterized by patterns that are not only unhealthy but also inequitable and significantly strain environmental resources. According to Fanzo and Davis (2019) as well as Willett et al. (2019), these practices contribute adversely to public health and promote social disparities. Furthermore, the environmental impact of these practices is profound, with the global food system being responsible for approximately a third of global greenhouse gas (GHG) emissions. Notably, the European Union is listed among the top six GHG emitters, indicating a substantial environmental footprint from its food sector Crippa et al. (2021).

The accumulation of negative outcomes—ranging from environmental degradation to social inequalities and public health crises—signals a pressing need for a transformation of the food system. This transformation is crucial not only on a global scale but also at local levels, where immediate and tangible impacts can be observed and measured. One promising approach to catalyze this change locally is through community-based initiatives that focus on sustainable and health-promoting food practices.

In response to these challenges, our study proposes a model centered around a community-driven solution: a free cooking night that utilizes rescued local fruits and vegetables. These cooking nights, scheduled weekly over a period of five months, are designed to encourage healthier eating habits, promote local produce, and enhance social connectivity within neighborhoods.

Our study investigates the factors that hinder or encourage participation in such community initiatives and their impact on eating habits and social cohesion. According to Saxena et al. (2021), engagement in community initiatives is influenced by a variety of factors across individual, family, community, organizational, and policy levels. However, focusing on individual-level factors due to time constraints, key motivators for participation include alleviating personal issues, seeking social connections, and fostering a sense of community. Barriers, on the other hand, may include a lack of time, competing priorities, access difficulties, insufficient awareness, and cultural obstacles.

Cooking classes, as part of these initiatives, have been shown to positively affect psycho-social and behavioral outcomes, including improved attitudes, self-efficacy, and healthier food intake, although results can vary. Studies indicate a consistent, albeit modest, increase in fruit and vegetable consumption following participation in such programs Garcia et al. (2016); Hasan et al. (2019). For instance, school-based cooking classes have resulted in increased vegetable consumption among children, while similar interventions for adults have seen an increase in daily servings of fruits and vegetables Vaughan et al. (2024); Brown and Hermann (2005). Additionally, participation in community kitchens has been shown to increase social interactions Iacovou et al. (2013).

Based on this literature review, our study aims to explore the impact of the cooking night initiative on various aspects of community life. Our main research question focuses on how these cooking nights affect the weight and vegetable consumption of participants, as well as their social connections and influence on non-participants in the neighborhood. Through this research, we seek to provide insights into how localized actions can contribute to broader systemic changes in the food system.

## The Model

Our agent-based model has two types of agents: neighborhood residents and the locations of cooking workshops. Residents are characterized by a variety of attributes that affect their participation and the outcomes of cooking nights. These include personality type—i.e. introvert or extravert—, available time for participation, weight, curiosity level, home location within the neighborhood grid, historical attendance at cooking events, distance from home to the event, and initial vegetable consumption levels (See Table 1). The workshops themselves are characterized by their duration, focus on certain resident demographics, and specific location within the neighborhood (See Table 2).

| Variable Name | Type | Range | Description |
|---|---|---|---|
| Resident-type | Static | {Extravert, Introvert} | Personality type. |
| Resident-time | Dynamic | {30, 60, 90, 120} | Available time (min). |
| Resident-weight | Static | [0, $\infty$) | Weight in kg. |
| Resident-curiosity | Static | {0, 0.1, ..., 1} | Curiosity level. |
| My-home | Static | Cell | Home location. |
| Attend-count | Static | {0, 1, ..., 20} | Cooking events attended. |
| Resident-distance | Static | [0, 23] | Distance to event (units). |
| Travel-time | Static | [0, 23] | Travel time (min). |
| Initial-veg-consumption | Static | [0, $\infty$] | Veg. servings/day. |
| Bonds-with | Dynamic | [agent, agent] | Social links. |

Table 1: Attributes of Neighborhood Residents

| Variable Name | Type | Range | Description |
|---|---|---|---|
| Workshop time | Static | {40} | Duration of cooking night (min). |
| Workshop socialization | Static | {extravert} | Targets extravert residents. |
| Workshop skills | Static | {0.4} | Targets residents with a curiosity level of 0.4 and above. |
| Workshop dietary | Static | {76} | Targets residents weighing at least 76 kg. |
| Workshop location | Static | Cell | Location of the cooking night. |

Table 2: Attributes of Cooking Night

Given the conditions for a resident and a workshop location, the attendance probability is calculated based on the score, which is incremented for each condition met. The conditions are:

1. The workshop time is less than or equal to the resident's available time minus travel time.
2. The workshop dietary requirement is less than or equal to the resident's weight.
3. The workshop socialization type matches the resident's type.
4. The workshop skill level requirement is less than or equal to the resident's curiosity.

Let's define the following variables:

$$
\begin{aligned}
T_w &= \text{workshop time} \\
T_r &= \text{resident's available time} \\
D_w &= \text{workshop dietary requirement} \\
W_r &= \text{resident's weight} \\
S_w &= \text{workshop socialization type} \\
S_r &= \text{resident's type} \\
K_w &= \text{workshop skill level requirement} \\
C_r &= \text{resident's curiosity} \\
t &= \text{travel time}
\end{aligned}
$$

The score $S$ is calculated as follows:

$$
S = \begin{cases} 1 & \text{if } T_w \leq T_r - t \\ 0 & \text{otherwise} \end{cases} + \begin{cases} 1 & \text{if } D_w \leq W_r \\ 0 & \text{otherwise} \end{cases}
$$
$$
+ \begin{cases} 1 & \text{if } S_w = S_r \\ 0 & \text{otherwise} \end{cases} + \begin{cases} 1 & \text{if } K_w \leq C_r \\ 0 & \text{otherwise} \end{cases}
$$

The attendance probability $P$ is then calculated as:

$$
P = \frac{S}{4}
$$

The model operates over a 20-week timeline and serves to evaluate the impact of these community gatherings on participants' health and social engagement. The model simulation runs for 20 time steps, each representing a week, during which a cooking night is held. The processes involved include setting up initial attributes for residents and the cooking night location, followed by a sequence of actions where residents evaluate their ability and interest to participate based on their personal attributes and the attributes of the event. During the cooking nights, participants engage in activities that promote social bonding and may adjust their dietary habits based on the interactions and experiences at the event. Post-event, residents may influence non-participants through social interactions, spreading information and potentially modifying community behaviors and perceptions regarding healthy eating and social engagement.

The foundational principles of the model are based on empirical data and established relational dynamics to simulate the complex interactions within a food environment. For instance, participation in cooking nights is hypothesized to increase vegetable consumption, which in turn may lead to weight management improvements. The model incorporates elements of stochasticity to reflect the variability and unpredictability of real-world behaviors and outcomes. For example, resident weight and initial vegetable consumption are modeled using random distributions to simulate diversity in the population. The model also explores the formation of social networks during cooking nights, emphasizing the collective dynamics that emerge from these community interactions.

The model is implemented in NetLogo, allowing for detailed behavior simulation and analysis. Initial conditions are set by randomly distributing residents across a predefined grid, establishing their attributes based on the model's design principles. Cooking night characteristics are also initialized, setting the stage for the weekly events. Data is collected throughout the simulations.

The following subsections describe how key parameters in the model are dynamically updated throughout the simulation. These updates are crucial for capturing the evolving behaviors and interactions of residents within the community. Specifically, we detail the mechanisms for updating curiosity levels, vegetable consumption, weight, and social links, which collectively influence the overall outcomes of the cooking night interventions.

## Curiosity Update

The agent's curiosity is dynamically updated through interactions with neighbors who have attended workshops. Initially, each resident agent is assigned a curiosity level based on their personality type, with extraverts likely to have higher curiosity values compared to introverts. During each simulation tick, if a resident has not attended a workshop and has not updated their curiosity based on neighbors' attendance, they assess the number of their neighbors who have attended workshops. The curiosity update mechanism is tiered, meaning that curiosity increments are applied based on the cumulative number of workshop attendances observed among neighbors, divided into five discrete levels. Specifically, the increments are 0.1 for 1 attendances, 0.08 for 2 attendances, 0.07 for 3 attendances, 0.06 for 4 attendances, and 0.05 for 5 or more attendances. This tiered approach reflects a diminishing impact of repeated exposure to workshop attendees. When a resident's curiosity is updated based on neighbors' attendance, their curiosity increases by the calculated amount, and the corresponding update flag is set to true, preventing further updates for that level during subsequent ticks. This mechanism ensures that curiosity is influenced by social interactions and varies according to the degree of exposure to workshop participants within the agent's local network.

## Update of Vegetable Consumption

The vegetable consumption of resident agents is updated based on their attendance at cooking workshops. Initially, each resident is assigned an initial vegetable consumption level, drawn from a normal distribution. The model assumes that attending workshops influences the resident's vegetable consumption, with a notable increase after attending a certain number of sessions. Specifically, if a resident attends between 3 and 8 workshops, their vegetable consumption increases by 0.1 servings per day for each workshop attended beyond the second, up to the eighth workshop. For residents attending more than 8 workshops, the increase in vegetable consumption is 0.6 servings plus an additional 0.05 servings for each workshop attended beyond the eighth. This increment reflects a diminishing return on vegetable consumption as the number of workshops attended continues to rise. The updated vegetable consumption is then used to calculate the change in consumption from the initial level, which subsequently influences other parameters such as the resident's weight.

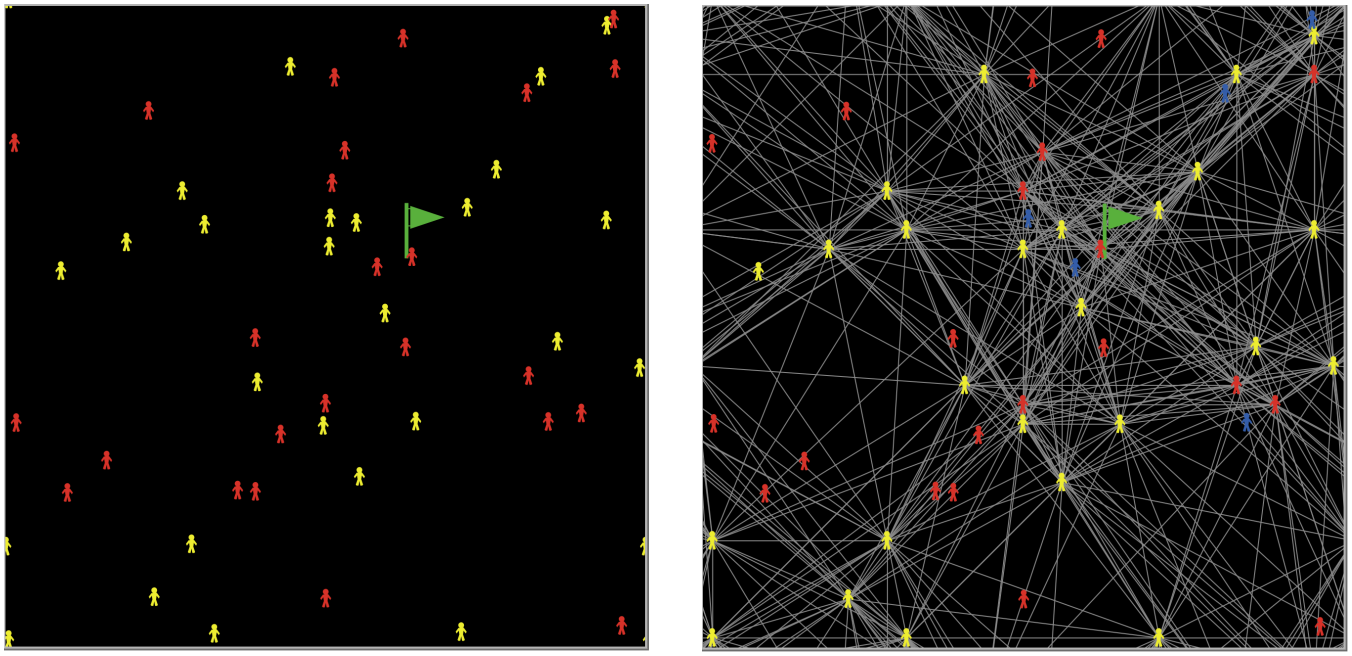
## Weight Update

The weight update mechanism in the simulation adjusts each resident's weight based on their changes in vegetable consumption. Initially, each resident is assigned a vegetable consumption level based on a normal distribution (as mentioned above), and their initial weight is similarly set. During the simulation, residents attend workshops that influence their vegetable consumption.

Each additional serving of vegetables results in a weight decrease. For example in Nour et al. (2018), authors report a weight loss of 0.1 kg per additional serving of vegetables. The change in vegetable consumption is divided into six intervals, each corresponding to a specific range of consumption changes: [0-0.2], [0.2-0.4], [0.4-0.6], [0.6-0.8], [0.8-1], [1-.2]. The agent's weight is only updated once per interval. The weight decrease for each interval is calculated as approximately $0.02$ kg per interval, based on a total decrease of $0.1$ kg per additional serving of vegetables. This mechanism ensures precise and consistent updates to residents' weights based on their vegetable consumption changes, reflecting realistic dietary impacts on weight.

## Update Social Links

The social links of agents are updated through interactions at workshop locations. When a resident agent attends a workshop, they have the opportunity to meet and create links with other resident agents who are also present at the same workshop. Specifically, upon attending the workshop, each agent checks for other residents at the location who are also marked as attending the workshop. For each encountered agent, the model creates a social link if one does not already



(a) Resident distribution in the neighborhood at week 1.

(b) Resident interactions at week 15.

Figure 1: Simulation snapshots of resident distribution and interactions in the neighborhood. Yellow agents represent extravert residents, while red agents represent introvert ones.

exist. This process ensures that social links are dynamically formed and maintained based on shared activities and interactions, thus simulating a realistic social network where links are strengthened through repeated and meaningful interactions at common locations.

## Results and Discussion

Our findings suggest that the introduction of community cooking nights enhances vegetable consumption among participants. Initially, the average vegetable intake was 3.4 servings per day, which increased to 4.6 servings by the end of our study, demonstrating an enhancement in dietary habits (Figure 2). This increase can be attributed to several specific parameters in the model. Each resident was assigned an initial vegetable consumption level drawn from a normal distribution, ensuring a realistic starting point for all agents. Attendance at cooking nights increased vegetable consumption incrementally: by 0.1 servings per day for each event attended beyond the second up to the eighth event, and by 0.05 servings per day for events beyond the eighth. This gradual increase was designed to mimic real-world dietary changes. Additionally, the model set a high engagement level for cooking nights, ensuring that most participants attended multiple sessions, progressively increasing their vegetable intake. Finally, vegetable consumption can be seen as a proxy for gaining healthy habits, and engaging in cooking nights can significantly enhance these habits. This is why we did not impose any cap on the maximum amount of consumed vegetables, allowing for the continuous growth of healthy eating behaviors.

Our results show a modest increase in resident curiosity, with an average rise of 0.008 (Figure 3). This change can be explained by the initial curiosity boosts provided by the model's design, where interactions with neighbors who attended workshops positively influenced curiosity. Residents were assigned an initial curiosity level based on their personality type, with extraverts generally having higher initial curiosity values than introverts. Curiosity increased through interactions, but the model restricted curiosity updates to a maximum of five times, with diminishing increments of 0.1, 0.08, 0.07, 0.06, and 0.05 for levels 1 through 5, respectively. This upper-bound limit ensured that curiosity boosts remained realistic and achievable, leading to sustained engagement in community activities beyond the cooking nights.

Furthermore, our analysis reveals that cooking nights facilitated the formation of new social connections, both within participants' neighborhoods and extending to different areas (Figure 4). The model's design included opportunities for residents to meet and interact at cooking events, directly contributing to the increase in social links. Residents started with a baseline number of social connections, which was low to simulate the need for increased social interaction. The probability of forming new social links was high when residents attended workshops, with the model specifying a significant increase in the chance of forming new con-

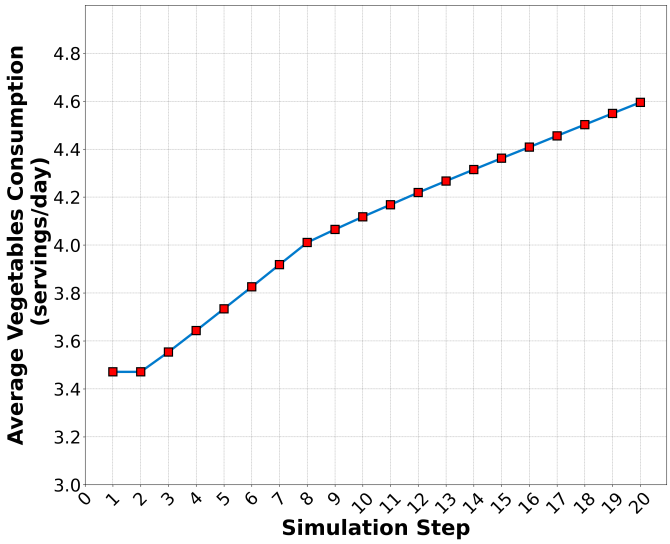



Figure 2: Average vegetable consumption of residents over 20 weeks.

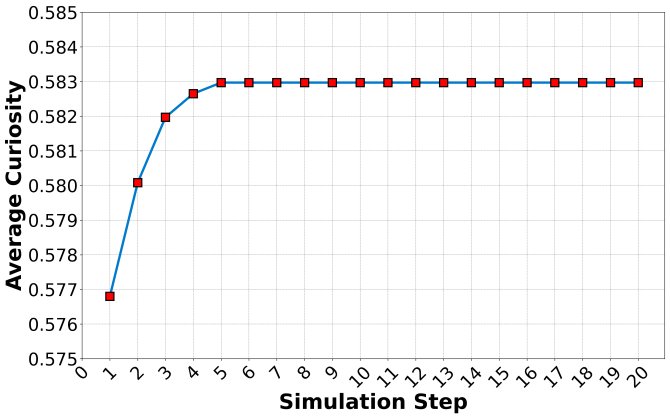



Figure 3: Average curiosity levels of residents over 20 weeks.

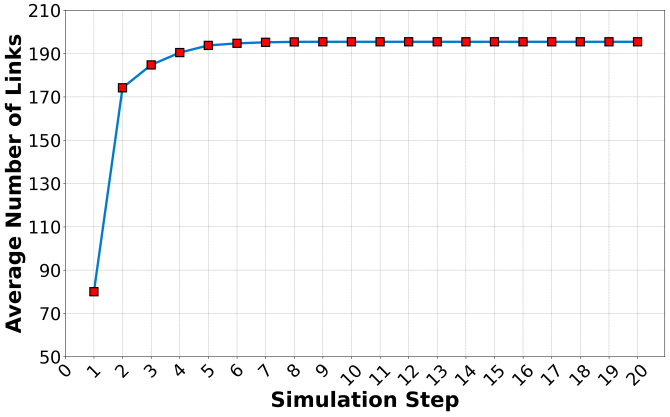



Figure 4: Average number of social links formed by residents over 20 weeks.

nections for each workshop attended. Once formed, social links were maintained unless explicitly severed, mimicking real-world lasting relationships. However, the persistence of isolated individuals suggests that additional strategies may be needed to engage all residents fully.

Finally, regarding weight changes, our results indicate a slight reduction in average participant weight from 75.0 kg to 74.8 kg (Figure 5). This modest weight reduction can be attributed to the short duration of the intervention and the model's parameters, which incorporated a moderate increase in vegetable consumption as a primary driver for weight loss. Each resident was assigned an initial weight based on a normal distribution to reflect a realistic starting point. The model specified that each additional serving of vegetables resulted in a weight decrease, with the impact divided into six intervals corresponding to specific ranges of consumption changes. Each interval resulted in a weight decrease of approximately 0.02 kg, based on a total decrease of 0.1 kg per additional serving of vegetables. This incremental approach demonstrated the need for sustained dietary improvements to achieve significant weight loss. The significant narrowing in weight variability among participants suggests a uniform impact across the population.

The results indicate that community-based interventions, such as the cooking nights modeled in this study, can positively influence dietary habits and social cohesion. Future research could explore longer-term interventions and consider additional factors such as family involvement, community support, and policy implications to enhance the impact. Moreover, addressing the barriers to participation for isolated individuals could further strengthen the outcomes.

## Conclusion

In conclusion, our study demonstrates that community cooking nights can play a significant role in promoting healthier eating habits and fostering social connections. The model's design and parameters were effective in achieving these outcomes, highlighting the potential for similar interventions in other communities. Future research should focus on extending the duration of the interventions and exploring broader systemic changes to maximize the benefits of such programs. Furthermore, future research should investigate the correlation between curiosity and extraversion. Understanding how these traits interact could reveal insights into engagement and social cohesion.

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Figure 5: Average weight of residents over 20 weeks.


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