Research Article

School Nutrition Stakeholders Find Utility in *MealSim*: An Agent-Based Model

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ABSTRACT

Objective: To obtain feedback from school nutrition stakeholders on an agent-based model simulating school lunch to inform model refinement and future applications.

Design: Qualitative study using online discussion groups.

Setting: School nutrition professional stakeholders across the US.

Participants: Twenty-eight school nutrition stakeholders.

Phenomenon of Interest: Perceptions and applicability of *MealSim* for school nutrition stakeholders to help reduce food waste.

Analysis: Deductive approach followed by inductive analysis of discussion group transcripts.

Results: Stakeholders appreciated the customizability of the cafeteria characteristics and suggested adding additional characteristics to best represent the school meal system, such as factors relating to school staff supervision of students during meals. The perceived utility of *MealSim* was high and included using it to train personnel and to advocate for policy and budgetary changes. However, they viewed *MealSim* as more representative of elementary than high schools. Stakeholders also provided suggestions for training school nutrition administrators on how to use *MealSim* and requested opportunities for technical assistance.

Conclusions and Implications: Although agent-based models were new to the school nutrition stakeholders, *MealSim* was viewed as a useful tool. Application of these findings will allow the model to meet the intended audience's needs and better estimate the system.

Key Words: school nutrition, agent-based model, food waste reduction (*J Nutr Educ Behav.* 2024;000:1−9.)

Accepted February 27, 2024.

INTRODUCTION

An estimated 508,000 tons of food were wasted in kindergarten through 12th-grade school settings in 2019,[1] primarily stemming from cafeteria plate waste.[2] Concurrently, more than half of US children have poor eating patterns,[3] and the National Health and Nutrition Examination Survey 2017−2018 reported children aged 2−18 years are consuming <1 cup of vegetables per day[4] falling short of the 2020−2025 Dietary Guidelines for Americans.[5] The *National School Lunch Program* (NSLP) is a federally funded program that provides nutritious meals to US youth.[6] In 2019, the NSLP served 4.9 billion school lunches to children in kindergarten through 12th grade from public, nonprofit private schools, and residential child care institutions at the cost of $14.2 billion.[7] Although nutrition standards for federally reimbursable meals outlined in the Healthy, Hunger-Free Kids Act of 2010 provide American children with a variety of healthy foods,[8] the School Nutrition and Meal Cost Study data suggest that, on average, 31% of vegetables, 26% of fruit or 100% fruit juice, and 29% of milk are wasted during lunch service.[9] Discarding edible food wastes the resources that go into growing, producing, processing, and transporting the food. Globally, wasted food negatively impacts the environment by contributing to excess freshwater and energy use, carbon dioxide, and greenhouse gas emissions.[10,11] The economic losses of throwing away edible food affect individuals and organizations, such as schools.[11]

Organizational, microenvironmental, and macroenvironmental factors

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Conflict of Interest Disclosure: The authors have not stated any conflicts of interest.

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https://doi.org/10.1016/j.jneb.2024.02.008

—including policies, insufficiently trained staff, type of food available to procurement, length of time available to eat, consumer expectations and behavior, and lack of consumer knowledge—contribute to food waste.[12] Nudges such as increasing the number of fruits and vegetables, slicing fruit, attractively displaying fruit and vegetables, posting nutrition information in the cafeteria, and altering the placement of fruits and vegetables may be implemented in school cafeterias to improve food behaviors.[13] However, these approaches may not consider the complexity of school meal environments and the interrelated problems of food waste and dietary behavior, which requires a systems approach that is missing from the existing literature.[14]

Computational simulation models are applied to study complex systems in the public health literature.[15] An agent-based model (ABM) is a simulation model that can represent complex systems with agents, such as students, capable of interacting with other agents and their environments. Agent-based models have been used extensively in infectious disease epidemiology research and have been more recently applied to study childhood obesity prevention,[16] fruit and vegetable preferences among school children,[17] and coronavirus disease 2019 transmission in US school settings.[18] For example, Schauder et al[17] used administrative and secondary datasets to develop an ABM to simulate how different patterns of exposure to the *Fresh Fruit and Vegetable Program* (FFVP) affect fruit and vegetable preferences and how residing in a food desert changes the impact of the FFVP. They found that FFVP may be most beneficial for those living in areas lacking access to healthy foods and that consistent exposure to FFVP is the most effective form of the intervention.[17] Simulation approaches save time, effort, and resources by identifying what interventions are most suitable for real-world applications.[19] This may be particularly relevant to school cafeteria experiments, which are notoriously challenging to conduct.[20,21] However, this approach has not yet been applied to the NSLP. To address this gap, the current research team developed *MealSim*, an ABM, to help school nutrition directors and researchers address the challenges with food consumption and food waste in the NSLP.

Engaging stakeholders throughout the development of the ABM leads to cross-sector communication, consistent language for policy changes between researchers and stakeholders, and collaborative implementation and dissemination.[22] It is important to involve stakeholders in the decision-making process to increase the adoption and use of the ABM and increase the trustworthiness of the data output.[19] This study aimed to obtain feedback from school nutrition stakeholders on *MealSim* to inform refinement and future applications of the model. Three research questions are addressed in this study: (1) How well does *MealSim* represent the school nutrition environment? (2) How do stakeholders view the potential utility of *MealSim*? (3) What are the best methods for *MealSim* publication and dissemination?

METHODS

This is a qualitative study using online discussion groups with school nutrition professional stakeholders. The discussion groups were derived from traditional focus group guidelines.[23] Stakeholders were recruited from the Academy of Nutrition and Dietetics School Nutrition Services Dietetics Practice Group (SNS DPG), whose membership includes child nutrition programs staff at administrative, district, and school levels.[24] The SNS DPG advertised the discussion groups as an interactive webinar on their email distribution list. Members of the SNS DPG who were interested in participating in the interactive webinar were asked to register and submit their sector of employment. One continuing education credit was provided to each participant in lieu of a monetary participation incentive. There were no inclusion or exclusion criteria; anyone who registered for the interactive webinar was allowed to participate. This study was approved by the University of Illinois Institutional Review Board and deemed exempt. All webinar registrants received a passive informed consent form before participation.

The stakeholders attended a 30-minute webinar led by the *MealSim* principal investigator to discuss how a systems approach to school nutrition operations can help identify evidence-based solutions to improve student diet quality and reduce school food waste. Stakeholders were introduced to *MealSim* during the webinar through a *MealSim* demonstration. Following the webinar, stakeholders were asked to join recorded breakout rooms for discussion groups lasting up to 25 minutes.

MealSim is designed in NetLogo to replicate the operation of a school meal program and the dietary behaviors of student participants, which are underpinned by econometric models and data from cafeteria experiments. As shown in the Figure, users begin by engaging with sliders, switches, and choosers to customize the *MealSim* model for their school nutrition program. Sliders adjust variables such as average daily participation rate without recoding, whereas switches toggle true/false variables such as universal free lunch status. Choosers allow selection from a dropdown menu for options such as lunch period duration. Additional customization options include total student enrollment, cafeteria capacity, number of lunch periods, grade span, first-period lunch start time, recess timing, kitchen type, and share table status (a share table is a location in the school cafeteria in which students can place unwanted food and beverage items to be either consumed by other students, reused in other lunch periods, or donated off-site). During the webinar, participants viewed a *MealSim* demonstration (Figure), which began with setting up the model according to a mock school's characteristics. Once the webinar speaker clicked execute, the first simulated lunch period began, and students (represented by colorful dots) went through the service line. In real-time, the selection results began to populate the selection histogram. Each lunch period

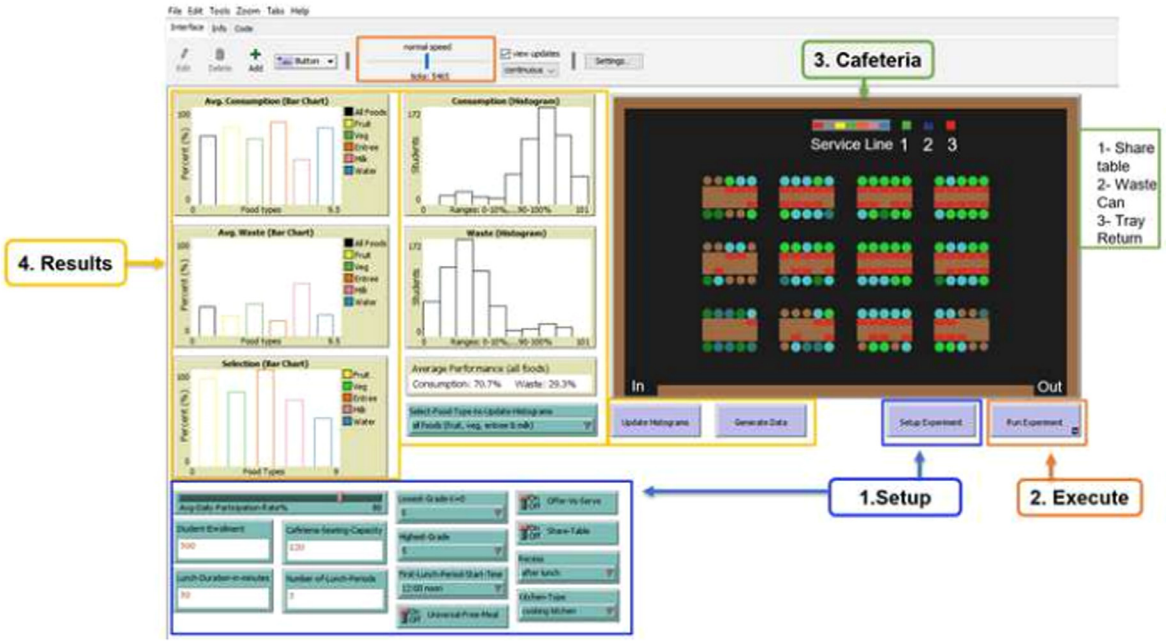

Figure. Denoted *MealSim* user interface. The numbers denote the order of user interaction with *MealSim*. The user begins by clicking Setup Experiment, selects their cafeteria attributes (circled in blue), and then clicks Execute. The speed of the simulation is controlled by the tick marker (orange). Users can view student actions in the Cafeteria part of the display (green). The results (yellow) are updated in real-time via histograms.

progresses at a rate determined by the speed dial, with the 5 histograms and mean consumption and waste results populating accordingly. The webinar speaker also shared that the simulation outputs (ie, selection, consumption, and waste outcomes) can be exported to Excel by selecting generate data.

Participants were informed that because *MealSim* is data-driven, users can execute simulations to evaluate the potential impact of alternative policies on school meal outcomes of interest. For instance, school nutrition directors can use *MealSim* to explore the impact that different lunch period durations will have on food waste. To increase the uptake of *MealSim* by US schools, the model was designed with an easy-to-use point-and-click interface that allows users to see the operation of their meal programs on a computer screen in real-time, thereby improving the model's transparency and enhancing users' confidence in the predictions that *MealSim* generates.

Data Collection

A total of 10 discussion groups were conducted in March, 2022. Between 1 and 5 stakeholders were in each discussion group. Stakeholders were assigned to a group on the basis of their sector of employment (experience using a share table, national/state-level administration, district-level administration, school-level, industry, and others). Each discussion group was moderated by a member of the research team who was trained in qualitative research methods and one additional researcher who provided supplemental notes. The moderators used a semistructured interview guide (Supplementary Table) to facilitate discussion and feedback on the model. The questions were largely based on the methods of Seifu et al,[19] and they were also designed to test model assumptions, as recommended by Nianogo et al.[25] The questions were pilot-tested on an adult convenience sample of research staff and graduate students with expertise in school nutrition programs. The questions asked participants to provide overall feedback on the model, test assumptions the model made, self-report the timing of the lunch process from the service line, seated time to end of lunch, the frequency of using share tables if currently implementing one, future use of the model, necessary training, and ways to publicize the model. Because stakeholder feedback can be particularly useful to assess model assumptions, 1 question was asked for feedback on our assumption that school lunch lines finish within 7 minutes of the lunch period. This estimate was based on past lunch observations conducted by the principal investigator, but there is a dearth of published literature to confirm this assumption. In addition, there is a lack of research studies on school share tables, and participants indicating familiarity with share tables on the registration were asked to estimate the frequency of share table use to inform *MealSim*'s share table assumptions.

Each discussion group had 5 open-ended, prioritized questions. The

questions differed across the groups, depending on the sector of employment. After the priority questions were asked and if time allowed, moderators asked additional questions. With many groups asking the additional set of questions, each question was asked at least 2 times among 2 different stakeholder groups. Not all groups responded to all questions, as not all questions were relevant to each area of employment. At the end of the session, stakeholders were invited to provide written feedback to the research team.

Data Analysis

All interviews were transcribed verbatim using a transcription service through Rev.com. Researchers used a hybrid process of deductive and inductive thematic content analysis.[26] Initially, 3 team members developed a deductive codebook on the basis of the structure of the questions asked and research questions. The majority of themes reflected the interview guide, and a few emergent (inductive) themes arose outside of the interview guide, such as the student's grade level and key players involved in processes. Themes from the interview guide included attributes and components of the model and the timing of the lunch process from selecting food all the way to the end of the lunch period codes were paired with participant attitudes and perceptions. There were also codes for future use of the model, necessary training, and potential dissemination outlets. Two trained team members independently coded all transcripts using the codebook. To support data reflexivity, the researchers acknowledge that these team members did not have prior work experience in school nutrition programs. All codes were reviewed by 2 team members. Any coding differences were discussed to reach a consensus between the 2 coders, with a third research member providing input as necessary. All coded transcripts were entered into a qualitative analysis software, Atlas Ti. Researchers used an inductive analysis of the codes to determine emergent themes. Illustrative quotations were identified for each theme that reflected participant ideas. Participants did not have the opportunity to comment on the transcripts or study results.

RESULTS

A total of 28 stakeholders participated in the discussion groups. Stakeholders were employed at the district-level school administrative position (n = 10), state-level or national-level administrative position related to school nutrition (n = 6), university professor (n = 4), industry related to school nutrition (n = 3), school nutrition services at an elementary school (n = 1), school nutrition services at a middle school (n = 1), dietetic intern (n = 1), and other (n = 2).

MealSim's Representation of the School Nutrition Environment

Stakeholders viewed the customizable characteristics such as the timing of recess, the student's grade, the start time of lunch, the number of service lines, lunch duration, and cafeteria seating capacity as useful model inputs.

> *I like that you can put in the lunch duration in minutes, and that you can put offer versus serve on or off or share table on or off and the recess before or after lunch. I like that you can customize it to your own lunchroom and simulate it, not have to do it in real life.* [state or national-level position]

Stakeholders viewed the customizable components of *MealSim* as readily available inputs into the model.

> *It seemed easy to use. I was worried at first. It looked very cumbersome. First view, having not been walked through it, I might have been deterred a little bit thinking how busy everyone is and my mind of immediate thought was, this is another layer to be asked to do, but then it seemed like information you would have off hand. You know your student enrollment, you know your lunch duration. So at first glance, it looked complex, but then once I saw that, it didn't seem complex.* [university professor]

Another customizable aspect is to indicate if the cafeteria has a share table, as this influences the output of food waste. Share tables also influence the layout of the cafeteria. Six stakeholders noted experience with share tables and were asked questions about the frequency of share table use. Stakeholders mentioned the most common items placed on the share tables were fruit, milk, and packaged vegetables. One stakeholder discussed how share tables help with food insecurity in their district. Another stakeholder mentioned that they see students frequently placing items on the share table and rarely taking items from it. After lunch service, stakeholders mentioned that the items left on the share tables were sanitized and reserviced.

To better represent school cafeteria characteristics, stakeholders suggested adding staff supervision during mealtime, a compost station, different layouts of the lunch line, the length of seated lunchtime, and allowing different cafeteria arrangements. Stakeholders believed the *MealSim* model they viewed best fit elementary school cafeterias, and it was unrealistic to use *MealSim* in higher grade levels:

> *In high schools the serving model [is more] a la carte and different serving locations, there's more at play. I could see [MealSim] being more useful... in elementary schools than in secondary schools.* [district-level position]

In addition to the suggestions of adding school-level characteristics to *MealSim*, stakeholders provided insights on the timing of the lunch processes, starting with entering the cafeteria to the dismissal process, including the estimated 7-minute average duration of time spent in the service line. Overall, participants reported that the service line time duration depends on the grade level of students, the number of service lines, and the complexity of the menu. As demonstrated by the following 2 quotes, generally, we assume that lunch line duration takes approximately 7 minutes, but some factors may contribute to longer line durations:

> *Elementary, I would say seven, eight minutes is probably normal for us. Sometimes if you're doing something like tacos that might take a little bit longer because they have to make choices. High school... lunch more kids come at the same time so it may be a little bit longer. We don't have options other than the normal meal so they stand in line as it goes through but it moves pretty quick.* [elementary school position]

> *Seven minutes is the goal, not to be over seven minutes. In our high school, if we have a grab and go line, that may go a little bit quicker than something that has to be served... with COVID, we scaled back on our salad bars, so students don't have as many choices. So I think lines are going a little bit fast now than before COVID because there's not as many choices.* [district-level position]

After students have their meal, stakeholders mentioned that it typically depends on the student's grade level for seating. "Elementary schools, they're normally assigned by classroom or by teacher. Junior high and high school students are able to pick where they sit" [district-level position]. Stakeholders noted the nuances of seated lunchtime among schools, and in some schools, lunchtime includes the time when students enter the cafeteria until they are dismissed. The dismissal procedure, stakeholders noted, often depends on the student's grade level. Frequently, older students have the autonomy to leave their seats throughout lunchtime, whereas younger students have a more structured dismissal.

Potential Utility of MealSim

Representative quotes from the school nutrition stakeholders on the perceived sources of utility and factors that limit the utility of *MealSim* are shown in the Table. Advocating for policy changes at the national and local levels was the most frequently reported potential use of *MealSim*. Reported policy changes include advocating for longer seated lunchtime, increasing school meal budgets, and altering the timing of recess.

Stakeholders also felt *MealSim* had applications for grade school and graduate school classrooms. One stakeholder mentioned that *MealSim* is a visual to teach children to become more aware of food waste in the cafeterias, and others suggested that *MealSim* may be a useful example to teach graduate students about policy, systems, and environmental change strategies. In addition, stakeholders suggested using *MealSim* to train school nutrition staff on cafeteria system- and environmental-level changes.

There were mixed perspectives on *MealSim*'s ideal degree of specificity, use of race as a customizable input variable, and output design. Some participants suggested that *MealSim* provides a broad understanding of plate waste or focused predictions specific to one's region. Participants who desired that race be a customizable variable felt that student-level race and ethnicity might allow them to evaluate the cultural appropriateness of the menus. However, others were concerned about the time required to locate and enter race data as they are less readily available. Others believed there are more important characteristics than race to take into account, such as geography and student socioeconomic status. For example, stakeholders believed that adding more school-level characteristics, such as race and ethnicity of students, rural vs urban location, percent of free and reduced-price lunch eligibility, varying cafeteria layouts for different grade levels, and the foods offered can help examine equity within school nutrition. Stakeholders believed that detailed characteristic options yielded the most relevant predictions of food behaviors for their school or district. Pertaining to the results output, stakeholders suggested offering different graphical layouts according to the intended use and audience. Another stakeholder suggested making *MealSim* more goal-focused, allowing end-users to set a goal for food waste and show when it is achieved.

Stakeholders also shared some concerns about using *MealSim*, such as the time it may take to learn, locate data, input characteristics, run, and evaluate the results of *MealSim*. Stakeholders noted that there may be a high learning curve with *MealSim*, which takes time away from their daily duties of preparing and serving students. Several stakeholders across multiple discussion groups asked where the plate waste data in *MealSim* was collected. Stakeholders questioned whether the data accurately reflected the diversity in school district characteristics and cafeteria arrangements. They asked questions about the interpretation of the plate waste results and the meaningfulness in their school or district.

Publicity and Dissemination of *MealSim*

To publicize *MealSim* to potential end-users, stakeholders suggested promoting the tool through professional associations and conferences —advertising through the School Nutrition Association (state and national level), school administrator meetings, and school nutrition staff meetings. To promote *MealSim* to school nutrition directors, stakeholders suggested offering potential end-users an opportunity to interact and practice using the platform. This provides end-users with a hands-on experience with the model vs passively attending a training session. Stakeholders believed that promoting *MealSim* with school business officials and with school board associations may elicit greater buy-in from administrators.

Stakeholders preferred an online training format. To minimize the amount of time needed for training, stakeholders mentioned offering a quick training webinar or recorded video they can watch anytime. In-person training was another option, but participants felt some may be encumbered by the required travel and time. For efficiency with training, stakeholders suggested offering training through various platforms to reach individuals with diverse technical skill levels. Stakeholders suggested having an opportunity for hands-on practice and providing end-users with examples of how other schools have effectively used *MealSim*. Topics to include in the

Table. School Nutrition Stakeholders' Perspectives on the Utility Delivered by *MealSim* and Potential Limiting Factors

Utility	Representative Quotes
Perceived *MealSim*	
Advocacy	"I would see using [*MealSim*] in my regular meetings with my business office, in a school board meeting or something like that presenting my budget or if you're asking for some kind of change within the district, it could be helpful." [district-level position] "I like seeing the difference between [amount of lunch time] has on the differential on waste. I think it's pictorial, so you could show that whether it's a principal or administrator or school board to pictorially show the impact of changing lunch times." [district-level position]
Educational value (staff, students, etc)	"I could use [*MealSim*] with supervisors and staff to try to convince them that for example not plating a fruit or vegetable or doing the offering bar and not doing the offering bar... I can see [*MealSim*] with managers, training them to show the importance of... how you offer and don't offer, you could run two or three models and show them the difference." [district-level position] "My viewpoint as an educator is how great this would be to introduce students as they're learning about the *National School Lunch Program* and to embed food waste into it as it becomes more of a discussion point with sustainability and getting kids involved... to teach kids to be more aware of the waste in the school cafeteria." [other]
Potential Factors Limiting *MealSim*	
Generalizability of the output to a school cafeteria environment	"[Add] the number of serving lines, because it impacts the number of staff and if you have more serving lines, you have the capability of getting more students through [the line] quicker. If you don't, you can only go as fast as the one line is." [state or national-level position] "When [*MealSim* shows] lunch duration time, is there a way to break that down into how long the kids are in line versus actual seat and eating time? I know it says cafeteria seating and capacity, but there's a big difference if there's a huge line and the last kids only get five minutes to sit and eat, what does that look like"? [state or national-level position]
Learning curve	"If you had a tool and had a place for [users] to practice [*MealSim*] and experience it. It would probably be a good way to publicize it because when one person in a unit is comfortable with it, I would think the odds increased that there's going to be acceptance of it and utilization a bit more." [university professor] "I would want some simple one, two, three, turn, click, go [for training]. Knowing if you want to use [*MealSim*] for food waste in a scenario, or if you want to change these scenarios, [show] what to look for... [For example] here's 10 examples of districts that have used [*MealSim*] effectively. Have a simple two to five minute YouTube video [for training]." [district-level position]

training are the benefits of ABMs, how to set up MealSim characteristics, how to export results, how to interpret and apply the results, and the length of time and financial resources needed from end-users. Stakeholders also suggested providing technical support for using *MealSim*, either a help desk, contact information, or a frequently asked question section. After training, stakeholders suggested testing end-user comprehension of *MealSim*, such as having a posttest.

DISCUSSION

In this qualitative study, school nutrition stakeholders provided input on *MealSim*, an ABM that simulates child eating behaviors in the NSLP. Participants reported largely positive feedback about *MealSim*; in particular, they liked the colorful and customizable display. However, there were concerns about the time required to learn how to use the model, locate data, and evaluate the model output. Participants most frequently reported potentially using *MealSim* for advocacy at the local, state, and national levels, such as advocating for longer seated lunchtime, increasing school meal budgets, and altering the timing of recess. Others were interested in using *MealSim* to train school nutrition staff, kindergarten through 12th-grade students, and college students. Although participants felt that *MealSim* represented the elementary school environment well, most felt that several adaptations were necessary to make the model applicable to higher grade levels. Participants suggested using professional associations and conferences to promote *MealSim* and requested that promotions include an opportunity to allow stakeholders to interact with and practice using *MealSim*. Participants also preferred online training formats and requested that technical support be available to users.

These findings are similar to those of Seifu et al,[19] who conducted qualitative interviews with policymakers

in government and nonprofit sectors to assess their perceptions of a model to simulate childhood obesity prevention interventions. Seifu et al[19] concluded that their simulation model required a visual display and contextualized results to overcome the policymakers' limited understanding of simulation models. In this study, school nutrition stakeholders were pleased with the visual display of *MealSim*. Although participants did not express challenges conceptualizing *MealSim*'s results, incorporation of a goal-setting component—as recommended by at least one participant—may further ensure that the model's results are fully tangible to the user. School nutrition stakeholders, similar to the policymakers interviewed by Seifu et al,[19] have a limited understanding of simulation models. The provided suggestions for *MealSim* training, such as online demonstration webinars, will be an important resource in overcoming this potential barrier. However, participants in both studies saw the potential utility of using simulations in their workplace. In addition, the policymakers[19] and school nutrition participants both stressed the importance of the quality and relevance of the data that are used to create simulation models. This suggests the vital role that data quality may have in ensuring public trust and the utility of simulation models.

These findings are important to the overall utility of *MealSim* and consistent with an open-science approach to agent-based modeling. Vermeer et al[27] contend that models must be more than accurate; they must be accepted, trusted, owned, and used by policymakers and community leaders to make informed decisions, and researchers "cannot afford to ignore stakeholders' value as resources." Put differently, stakeholders' engagement can broaden researchers' understanding of the system, resulting in a more robust model. Engaging key stakeholders during ABM development, rather than presenting them with a completed product, increases ABM utility and trust,[19,28] suggesting that it was appropriate to get feedback on *MealSim* despite the fact that more adaptations are needed to make the model fully representative of the school meal environment and meet the needs of stakeholders. Similarly, Falconi and Palmer[29] advocate for agent-based models that are co-generated with stakeholders and suggest that model confidence comes from stakeholders' understanding of the process and confirming model outputs with intuition or experience rather than seeing model outputs as arriving from a mysterious black box.

The most frequent *MealSim* adaptation requests centered around more nuanced time estimation. Participants desired to differentiate between seated and line time in the model. Although there are studies demonstrating the link between seated lunchtime and consumption,[30,31] there is limited evidence on the factors influencing the amount of time that students spend in line, making it difficult to incorporate this into *MealSim*. A 2003 study by Bergman et al[32] estimated that students spend 5–9 minutes in line, 9 minutes eating (with an SD of 5–7 minutes), and 5–10 minutes socializing. The participants in this study were agreeable to the 7-minute average line wait time used in *MealSim*, but they also spoke about wanting to customize *MealSim* to incorporate other factors that were related to line time duration, such as the number of food choices provided and number of service lines.

This study has limitations to consider. There were very few participants who worked at the school level, which primarily comprised school nutrition directors and administrators. This may be because the majority of SNS DPG are registered dietitians, and this credential is not required of school-level staff, whereas it is quite common among school nutrition directors and administrators. The lack of school-level participants may be why the potential utility of the model centered around advocating for policy change and training. Although school nutrition stakeholders across the country were invited to participate, it is unclear if the participants reflect the geographic diversity of the US because we did not ask participants to disclose the state in which they work. Because of the nature and time constraints of the online discussion groups, selected questions were asked in each group, and not everyone responded to the full set of questions. In addition, because data were collected over 1 day, qualitative saturation was not measured. Despite these limitations, the data analysis methods were of sufficient rigor, with 2 trained researchers coding each transcript.

In conclusion, this study suggests that a diverse group of school nutrition stakeholders view *MealSim* positively and can see themselves using *MealSim* to advocate for new policies and training purposes. Stakeholders wanted to know more information about the quality of the data used to develop *MealSim* and suggested that more nuanced environmental characteristics be integrated into the model, such as the number of staff and the amount of time spent in line. Findings suggest that online training and support resources are the preferred methods to support stakeholder use of MealSim.

IMPLICATIONS FOR RESEARCH AND PRACTICE

Although national policy changes have provided a mechanism to serve healthier school meals, the consequences of school and district-level policies, such as lunch period duration, often do not allow the impact of these national policies to be fully realized. The perceived utility of *MealSim* suggests the potential to empower school nutrition professionals with an advocacy tool to address these local policy issues and ultimately improve consumption and decrease the food wasted at their schools. This study underscores the importance of incorporating stakeholder perceptions in the development of agent-based models. Eliciting a feedback loop from the intended audience may help agent-based models reach a broad audience of implementers and support systems and, ultimately, policymakers. Given the capacity for agent-based models to explore the interplay between various agents and time, future research that provides data on the connections between the number of nutrition services staff and lunch monitors, number of food choices and menu complexity, time use, and food waste would best leverage the potential for *MealSim*'s impact on school nutrition

practices and policies. It will also be critical for *MealSim* to be accompanied by training and support resources to ensure that end-users are confident in their ability to use the tool and interpret its outcomes effectively. This includes seeking additional partner organizations, such as the School Nutrition Association, to better link school administrators, nutrition managers, and school-level staff to *MealSim* and resources for training and technical support. Further research should entail a more targeted enrollment, as it is also necessary to determine how school-level school nutrition staff may engage with *MealSim*.

ACKNOWLEDGMENTS

This research was supported by the intramural research program of the US Department of Agriculture, National Institute of Food and Agriculture (no. 2020-68015-30735). The findings and conclusions in this publication have not been formally disseminated by the US Department of Agriculture and Should not be construed to represent any agency determination or policy.

The authors would like to thank the SNS DPG for hosting the discussion group webinar and encouraging their members to attend. The authors would also like to thank Marina Brown, Xanna Burg, Maria Kalaitzandonakes, Jessica Metcalfe, Ana Mitchell, Gustavo Reyes, and Emily Siebert as moderators of discussion groups. Thank you to Paola Gordillo, Elizabeth Gutierrez, Julie Hwang, Colin Marsh, Vama Naik, Nan Ni, Donald Quach, Susannah Scaroni, and Emily Yong for being note-takers during the discussion groups. In addition, the authors thank Lauren Chermak for designing the final presentation slides.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jneb.2024.02.008.

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