Title: Using Facebook and Participatory Learning in an Intergenerational Intervention to Prevent Obesity in Head Start Preschoolers

IRB Approval ID: STUDY00001629

Funding: National Institute of Nursing Research of the National Institutes of Health under Award Number R21NR017958 (PI: Dr. Jiying Ling)

Clinical Trial Registration #: NCT04164277

Date: December 22, 2023

PROJECT SUMMARY

Despite persistent overweight/obesity (OW/O) disparities by socioeconomic status (SES), interventions targeting preschoolers from low-SES backgrounds are sparse. Based on the intergenerational transmission of habits and obesity, targeting preschoolers and their caregivers (parents or legal guardians) simultaneously is a promising strategy for the prevention of OW/O. **This project will** determine the preliminary efficacy of an innovative intergenerational intervention among Head Start preschoolers, aged 3-5 years, and their caregivers. **Methods:** A two-group cluster randomized controlled trial will be conducted. Six Head Start centers will be randomly assigned to the intervention (n=3) or control group (n=3), and 24 caregiver-preschooler dyads will be recruited from each center (N=144 dyads). Grounded in an Actor-Partner Interdependence Model (APIM), the 16-week intervention has 3 components: **1)** a caregiver component, including **1a)** a Facebook-based program with weekly electronic retrievable flyers providing health information and behavioral change strategies and 4 weekly habit-formation tasks to improve parenting practices and home environment for preschoolers; and **1b)** 3 face-to-face meetings (wks. 1, 8, & 16) to establish personal connections and communication networks among caregivers, discuss strategies, and share community resources to support preschoolers' behavioral changes at home; **2)** a caregiver-preschooler learning component via Facebook messenger to send preschooler letters to each caregiver privately by the research team twice per week to **2a)** share the preschooler's experiences of learning at school and his/her desires for a healthy diet and physical activity at home, and **2b)** elicit caregivers' response to the letters; and **3)** a Head Start center-based preschooler component to help preschoolers establish healthy habits via weekly healthy diet and physical activity participatory learning. **AIM 1:** Determine the preliminary efficacy of intervention vs control on preschoolers' proximal behavioral (e.g., MVPA, diet quality) and distal anthropometric outcomes (e.g., proportion of OW/O, BMI z-score). **AIM 2:** Examine the preliminary efficacy of intervention vs control on caregivers' behavioral and anthropometric outcomes. **AIM 3:** Compare intervention vs control on the bidirectional relationship (proposed in APIM) between preschoolers and caregivers on MVPA, diet quality, and screen time. **Innovation:** The intervention extends beyond prior research that focuses only on the unidirectional influence of caregivers on preschoolers with a bidirectional approach that also emphasizes the influence of preschoolers on caregivers. The potential for sustainability and scalability is high because the intervention is integrated into daily routines and capitalizes on the already-existing social network Facebook to connect caregivers to an online private group. It facilitates the communication of preschooler preferences to improve caregivers' parenting practices through preschooler letters sent to caregivers via Facebook messenger. **Impact:** The proposed study will set the stage for a future large-scale study to prevent and reduce OW/O and promote health among underserved preschoolers.

PROJECT NARRATIVE

Despite disparities in overweight/obesity (OW/O) by socioeconomic status (SES), preschoolers aged 3–5 years old from low-SES backgrounds have been underrepresented in OW/O preventive research. The proposed project, which includes low-SES caregiver-preschooler dyads and a rigorous study design, examines the preliminary efficacy of an innovative intergenerational intervention on preschoolers' proximal behavioral and distal anthropometric outcomes. This research stands to make a significant public health impact to reduce the prevalence of OW/O among underserved preschoolers, with high potential for intervention sustainability and scalability among an underserved population of concern to nursing researchers and practitioners.

SPECIFIC AIMS. Despite persistent disparities in overweight/obesity (OW/O) by socioeconomic status (SES),[12-14] and a sharp increase in obesity prevalence from 2015 (9%) to 2016 (14%) in preschoolers aged 2–5 years,[15] preschoolers of low SES are significantly underrepresented in OW/O preventive research.[16] Lifestyles promoting high-quality diet and physical activity (PA) offer the most effective approach to achieving healthy weight long-term[17-19] and reducing obesity-related comorbidities,[20] such as heart disease,[21,22] asthma,[23] impaired cognitive function,[24,25] metabolic syndrome,[26] and cancer.[27] Moreover, the major sociocultural root causes of OW/O in low-SES preschoolers are poor parenting practices and poor home environment.[8,9,28-30] Despite calls from the American Academy of Pediatrics (AAP) and the Institute of Medicine (IOM) for interventions to prevent obesity that primarily target preschoolers,[31,32] few interventions have been conducted with low-SES preschoolers and effects have been limited.[16,33] This study addresses this gap in the science in a novel manner by targeting the bidirectional participatory learning[34] that occurs between preschoolers and their parents or legal guardians (referred to as caregivers in this application) as an effective strategy for reducing the persistent OW/O disparities by SES[35] given the intergenerational transmission of health habits and obesity.[36,37]

Based on our prior study (n=69 dyads, see **C.2.**),[38] we have established the feasibility (preschooler participation 77%; caregiver participation 87%) of our 10-week, intergenerational intervention called "*FirstStep2Health*." This intervention addresses one important root cause of OW/O—poor parenting practices—by **1)** using an existing social network, Facebook™, to involve caregivers in a private group[39,40] to initiate a supportive network and overcome barriers to involving working caregivers in face-to-face programs;[41,42] and **2)** extending the commonly used unidirectional framework of caregivers shaping preschoolers to the *bidirectional* framework—the Actor-Partner Interdependence Model (APIM)[43]—that adds preschoolers' preferences and how they influence caregiver-preschooler learning of healthy diet and PA.[44-47]

Our **long-term goal** is to promote healthy parenting practices among underserved low-SES families to reduce OW/O disparities by SES. To achieve this goal, our **16-week** (extended from 10 to 16 weeks per caregiver request in our prior study and behavior habit-formation needs 2-3 months[48]) **intervention** is sensitive to participants' literacy level and low-SES and includes **3 components**: **1)** a caregiver component including **1a)** a Facebook-based program with weekly electronically-retrievable flyers providing health information and behavioral change strategies and 4 weekly habit-formation tasks to create a healthier home environment for preschoolers; and **1b)** 3 face-to-face meetings (weeks 1, 8, & 16) to establish personal connections and communication networks among caregivers, discuss strategies, and share community resources to support behavioral changes at home; **2)** a caregiver-preschooler learning component[34,47] via Facebook messenger to send preschooler letters to each caregiver privately by the research team twice per week to share the preschooler's experiences of learning at school and his/her stated desires for healthy diet and PA at home, and to ask caregivers to respond to the letters; and **3)** a Head Start center-based preschooler component to help preschoolers establish healthy habits via weekly healthy diet and PA participatory learning.[34]

Our **primary objective** is to determine the preliminary efficacy of the intervention. **Methods:** We will conduct a **two-group cluster randomized controlled trial** (RCT). From the available 13 large Head Start centers, six centers will be randomly selected and then randomly assigned to the intervention (n=3) or control group (n=3, usual Head Start activities); 24 caregiver-preschooler dyads will be recruited from each center (N=144 dyads).

AIM 1: Determine the preliminary efficacy of FirstStep2Health vs control among preschoolers on proximal behavioral changes of ↑ moderate-to-vigorous PA (MVPA) measured by accelerometry (primary outcome), ↑ diet quality (e.g., ↑ fruits/vegetables, ↑ fiber, ↑ whole grains, ↑ total protein, ↑ dairy, ↓ sugar-sweetened beverages, ↓ total sugars/fats), and ↓ screen time (e.g., watching TV, playing video games); and distal anthropometric outcomes of ↓ proportion of OW/O and ↓ body mass index (BMI) z-score. We anticipate an overall decrease in BMI z-score in intervention preschoolers because we expect OW/O preschoolers' BMI z-score to decrease and healthy-weight preschoolers to have no change. We focus on proximal behavioral changes as our primary outcome instead of distal anthropometric outcomes due to the brevity of this study and the need for behavioral changes to be maintained for at least a year before manifesting in changes in anthropometric outcomes.[49,50] **AIM 2: Examine the preliminary efficacy of FirstStep2Health vs control among caregivers** on their ↑ MVPA measured by accelerometry, ↑ diet quality (e.g., ↑fruits/vegetables, ↑fiber), ↓ screen time, ↓ proportion of OW/O, ↓ BMI, ↑ knowledge, ↑ feeding practice skill, ↑ self-efficacy, ↑ parental support of their child, ↑ parenting practices, and ↑ home environment. **AIM 3: Compare FirstStep2Health vs control on the bidirectional relationship** (as demonstrated in the APIM) between preschoolers and caregivers on MVPA, diet quality, and screen time. Further, we will **validate established feasibility, acceptability, and satisfaction of the intervention using qualitative and quantitative data**.

Impact: This application integrates existing best practices for preventing OW/O into an innovative intergenerational intervention that targets caregivers via existing social network Facebook™ and promotes caregiver-preschooler learning based on a bidirectional framework. This study forms the foundation for a future large-scale RCT to prevent OW/O and promote health among low-SES preschoolers.

A. SIGNIFICANCE **A.1. A critical need exists to reduce overweight/obesity (OW/O) among preschoolers in low-socioeconomic status (SES) families.**[13,14] About 34% of U.S. Head Start preschoolers[51,52]—1.3 times the rate of U.S. children aged 2-5 years (26%)[15]—are OW/O. The OW/O prevalence rate was 46% in our prior study.[38] Disparities in OW/O by SES persist from childhood through adolescence[53] and are related to underlying SES disparities in dietary intake[54] and PA.[55] Children who experience poverty by 2 years of age are almost two-times more likely to be obese by age 15 compared to those not experiencing poverty at an early age.[56] Head Start programs serve children and families with incomes under the poverty thresholds.[57] **This research is significant because it addresses the gap in literature involving studies targeting both preschoolers and their caregivers from low-SES backgrounds**.[16,33,58] Intervening with preschoolers <5 yrs. old results in better short- and long-term outcomes in weight reduction compared to intervening with elementary school children (6–11 yrs.) or adolescents (≥12 yrs.).[17,18,59] Six interventions were identified that focused on low-SES Head Start preschoolers (including healthy weight and OW/O preschoolers). Two interventions used passive caregiver involvement by sending home materials, but had no effect on preschoolers' BMI.[60,61] Four interventions actively involved caregivers via face-to-face classes: one resulted in a significant but small BMI decrease (*d*=0.17), but lacked control group and caregiver attendance data;[62] two had no significant BMI change with low caregiver attendance (32-38%);[41,63] and one used a quasi-experimental design and had a high caregiver attendance (80%), but no significant BMI change.[64] The high attendance may have occurred because only caregiver-transported preschoolers were included, and caregivers received the intervention when they arrived to pick up their child. Moreover, previous interventions with preschoolers only achieved a small effect on BMI (*d*=0.19), and the effect was even smaller (*d*=0.10) when including ≥ 50% low-SES preschoolers.[16,65] These dismal results, coupled with the sharp increase in obesity prevalence from 2015 (9%) to 2016 (14%) in preschoolers[15] and the low percentages of Head Start preschoolers meeting fruit/vegetable (9%)[66-68] and MVPA (50%)[69,70] recommendations, highlight the critical need for this innovative intergenerational intervention. Furthermore, health habits established in preschool years persist later in childhood,[71,72] highlighting the importance of introducing preventive efforts before entering kindergarten.

A.2. SCIENTIFIC PREMISE. The **major root causes of OW/O** in low-SES preschoolers and their primary caregivers include unhealthy diet (e.g., excessive sugar drinks and fat intake, increased portion size, low intakes of fruits and vegetables),[6,73] decreased PA,[6] increased screen time,[74,75] poor parenting practices, and home environment.[28-30,76] Previous interventions involving caregivers via face-to-face contact[16,33,77] resulted in low attendance (32-38%) due to inflexible caregiver schedules.[41,42,63] Internet-based interventions resulted in similar or even greater effects on weight loss compared to non-Internet-based interventions.[78-80] However, they suffer high attrition and low usage rates.[81] To address these limitations, this research uses existing social networks (i.e. Facebook)[39] and incorporates activities into people's daily routines.[40] According to the Pew Research Center, about 80% of young U.S. adults[10] and 74% of U.S. parents[11] use Facebook. In our prior study, 91% of the participating young parents used Facebook. Facebook-based interventions have achieved high retention rates (77-100%).[39,40] To date, Facebook-based interventions have focused on changing Facebook users' behaviors directly[82-85] but no intervention has targeted caregivers via Facebook to improve support for their preschoolers' behavioral change. Some face-to-face contact is still crucial to connect caregivers to each other to initiate a communication network[86,87] and create norms to boost participation.[81] Guided by the promising findings of our prior study,[38] **we plan to extend this science in 3 ways: 1)** use the existing social network Facebook™ to form a private group with messaging designed to engage caregivers in the program and to create group norms to support ongoing interaction; **2)** actively engage both preschoolers and their caregivers to target major root causes of OW/O including diet, PA, screen time, parenting practices, and home environment; and **3)** send preschooler letters to caregivers via Facebook messenger to share their preschooler's experiences of learning at school, his/her stated desires for healthy diet and PA at home, as well as ask caregivers to provide nutritious foods and types of PA the preschooler has tried and liked. Thus, we will increase caregiver engagement and retention by forming a private homogeneous virtual community on Facebook, supplemented with limited face-to-face contact to maintain participation. Our Facebook-based program has resulted in high caregiver attendance (87%).[38] **To our knowledge, this intervention is the first to apply a *bidirectional* framework that captures not only caregivers' ability to influence their preschoolers but also preschoolers' ability to influence caregivers.** A bidirectional framework emphasizing the interaction between caregivers and preschoolers offers a new perspective for studying child behaviors.[88,89] Preschool is the time when a child's influence emerges. Erikson's psychosocial stage theory[90] indicates that children begin to assert autonomy by making choices about what they like between 18 months and 3 yrs. Children as young as 3 yrs. begin to have a significant role in influencing family food purchasing and consumption,[91,92] so increasing children's exposure to healthy choices will help increase their requests for

healthy items.[92] Intervening with preschoolers who begin to assert autonomy is very important to help foster an intimate, long-term, positive relationship between caregivers and children.[93-96] Prior research only emphasizes the influence of caregivers on preschoolers without considering caregiver-preschooler bidirectional influence.[45,46,97,98] Longitudinal, observational studies among preschoolers and school-age children have supported the influence of children's behaviors and weight status on parenting practices.[99-102] Experimental studies with school-age children further support that children's participation in a lifestyle intervention can significantly increase their parents' health knowledge,[103] improve home food environment,[104] and decrease parents' BMI.[105] Our study is based on the scientific promise that an intervention focusing on the bidirectional caregiver-preschooler relationship will improve behavioral and anthropometric outcomes among participants.

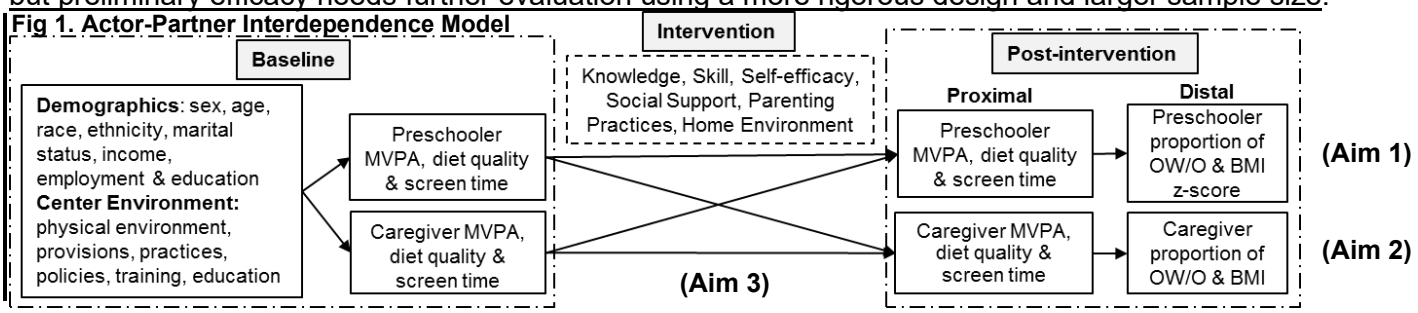
B. INNOVATION This intervention is innovative because it: **1)** is integrated into participants' daily routines without adding excessive burden to their daily lives to improve sustainability and scalability; **2)** applies a bidirectional framework emphasizing both the influence of caregivers on preschoolers and of preschoolers on caregivers; **3)** facilitates the communication of preschooler preferences to improve caregivers' feeding and activity practices through preschooler letters sent to caregivers via Facebook messenger; and **4)** connects caregivers through an online private group via social network Facebook to support and motivate each other. Additionally, we apply an innovative training method to assist Head Start teachers to transition from being intervention implementation assistants to classroom education leaders: **1)** MSU Extension health educators will deliver the intervention and model the role of interventionist with teachers observing for weeks 1–6; **2)** Extension health educators and teachers will deliver the intervention together for weeks 7–10; **3)** Teachers will deliver the intervention with Extension health educators providing on-site coaching and feedback for weeks 11–16. This training method was successful in our prior study and can help improve intervention sustainability.

C. APPROACH To ensure **rigor**, the study will use a rigorous design, reliable and valid instruments, and training and supervision to maintain ethical conduct and intervention integrity.

C.1. RESEARCH TEAM. Our multidisciplinary team includes researchers from nursing, nutrition, child development, engineering, and biostatistics. The team includes experts in preschooler obesity prevention (PI Ling, Co-I Kerver, & Consultant Brophy-Herb),[4,38,106] Internet/social network-based intervention (PI Ling & Co-I Robbins),[38,107,108] mHealth (Co-I M. Zhang),[109-111] and cluster RCTs (Co-Is Robbins & N. Zhang).[112,113]

C.2. PRELIMINARY STUDIES. In preparation for this application, we completed two systematic reviews[16,33] and two preliminary studies.[4,38,67,87] The systematic reviews[16,33] suggest that OW/O interventions should target preschoolers via participatory learning[34] and provide caregivers with parenting skill training and behavioral change strategies. One preliminary study,[4] with 32 Head Start caregivers, identified the unique needs and barriers to healthy behaviors in Head Start families and supported the intervention strategy of involving caregivers through an online support group supplemented with face-to-face meetings. The PI collaborated with the established research team on a quasi-experimental study to examine the feasibility and preliminary efficacy of the 10-week *FirstStep2Health* intervention.[38,67,87] Sixty-nine dyads participated (39 in intervention). About 81% of caregivers and 46% of preschoolers were OW/O, and 92% reported no difficulty to get the foods they needed.[3] **Feasibility**. Enrollment rate was 37% and retention rate was 99%. Preschooler participation was 77%, and caregiver participation was 87%. Completion rates for weekly tasks and quizzes were 82% and 88%, respectively. About 94% of caregivers were satisfied with the program; 97% would recommend the program to others. **Efficacy.** Intervention increased MVPA (raw *d*=0.42) and fruit/vegetable intake (*d*=0.40), and decreased screen time (*d*=-0.21) and BMI z-score (*d*=-0.30) in intervention preschoolers. It also increased caregivers' fruit/vegetable intake (*d*=0.40), but had a small effect on their MVPA (*d*=0.08) and BMI (*d*=-0.07). **Suggestions**. Fifteen randomly selected caregivers were interviewed individually. They suggested: **1)** holding each caregiver meeting on both weekday and weekend so working caregivers can attend; **2)** covering topics on alternative cooking ingredients and portion size control during the meeting; **3)** promoting more interactions via commenting on others' postings; **4)** including quick meal recipes and healthy snack ideas in the intervention cookbook; and **5)** extending the program a few more weeks. Results support the feasibility of the intervention, but preliminary efficacy needs further evaluation using a more rigorous design and larger sample size.

Fig 1. Actor-Partner Interdependence Model



C.3. CONCEPTUAL FRAMEWORK (**Fig 1**). The intervention is guided by an Actor-Partner Interdependence Model (APIM),[43] which has been used in behavioral interventions to better understand the intergenerational relationships inside a family.[114-116] The APIM demonstrates the bidirectional relationship between preschoolers and caregivers: **1)** actor effects within preschoolers or caregivers, and **2)** partner effects between preschoolers and caregivers.[43] The proposed intervention targets both preschoolers' and caregivers' knowledge, skill, self-efficacy, and social support, derived from social cognitive theory,[117] and parenting practices and home environment[118-123] to improve their MVPA, diet quality, and screen time, thereby reducing the proportion of OW/O and BMI. Participatory learning[34] will be used to improve preschoolers' knowledge, skill, self-efficacy, and social support, but will not be assessed due to preschoolers' immature cognitive development.[124] Caregivers' learning[34] will be improved via weekly habit-formation tasks on child feeding practices and PA and preschooler letters where preschoolers describe their desires for healthy diet and PA at home. Through simultaneously targeting both preschoolers and caregivers to maximize the actor and partner effects, the intervention is hypothesized to result in positive outcomes.

C.4. STUDY DESIGN. To decrease cross-group contamination among participants in the same location,[125] we will employ a rigorous two-group cluster RCT design by randomizing 6 centers so participants in one center are in the same group. Data will be collected at baseline (wk. 0) and immediately post-intervention (wk. 17).

C.5. SETTING & SAMPLE. Six Head Start centers (≥ 4 classes/center) will be randomly selected from the Capital Area Community Services (CACS) Head Start and Early Childhood Programs and the Head Start for Kent County, which had 13 centers with ≥ 4 classes in 2017.[126,127] Among the 13 centers, two had 4, one had 5, five had 6, one had 8, one had 9, two had 12, and one had 14 classes. The 13 centers cared for 1,932 preschoolers: 49% female, 20% Hispanic, 38% Black, and 39% White. Four classes will be randomly selected from each center, and 6 caregiver-preschooler dyads will be randomly selected from the eligible participants in each class (total: 6 centers, 24 classes, and 144 dyads). Inclusion and exclusion criteria are specified in **Table 1**.

Table 1. Inclusion and Exclusion Criteria

Preschoolers	**Caregivers**
Inclusion Criteria	
Parental written consent	Provide written consent
Understand and speak English	Read, understand, and speak English
3-5 years old	Primary adult caregiver (≥ 18 years old)
Enrolled in full-day or half-day Head Start program	Have at least weekly Internet access using a smartphone, tablet, or a computer
Child written assent if 5 years old	Willing to use Facebook
Exclusion Criteria for both Preschoolers and Caregivers	
Medical conditions precluding dietary changes or PA	
Diagnosed conditions known to impact weight (e.g., Prader-Willi Syndrome) or taking weight-affecting medications (e.g., stimulants)	
Diagnosed developmental disabilities	Diagnosed mental health problems

C.6. SAMPLE SIZE & POWER. Due to the exploratory/developmental focus of this R21 grant proposal, our aim is to estimate effect sizes for proximal and distal outcomes in preschoolers to serve as foundation for future research. Assuming class cluster effects intraclass correlation (ICC)=0.01,[128,129] and significance level=.05, a sample size of 130 will provide a power of .80 to identify an effect size of 0.50, < 0.66 for MVPA achieved in the prior study after adjusting for demographics.[38] Given the extended intervention duration from 10 to 16 weeks and the strengthened intervention, we anticipate to also achieve an effect size of 0.50 in preschoolers' diet quality, screen time, and BMI z-score. We conservatively assume a 10% dropout.

C.7. RECRUITMENT. The two Head Start organizations have agreed to support implementing the proposed project in their Head Start centers (**Support Letters**). Based on our prior experiences working with Head Start families, we anticipate ≥ 6 of 18 (30%) dyads per class will be willing to participate. Replacement classes will be randomly chosen if a selected class teacher refuses to participate. Building on lessons learned from prior studies and recommendations from Head Start administrators, we will involve Head Start family advocates to help with recruitment because they already have an established, trusting relationship with each family. The PI and project manager (PM) will provide participant recruitment training with communication scripts to family advocates to ensure consistency. Family advocates will distribute the recruitment packet (including cover letter, parental consent/child assent, & screening tool) in an envelope and explain the study to each caregiver in person. Each family will be asked to return the packet in a sealed envelope to the family advocate. For non-respondents, the family advocates will make a follow-up phone call, and then another packet will be mailed to each family. Each family will be asked to return the packet in an attached, prepaid envelope. Cash ($5) will be provided for returning the packet. Prior to any data collection, written parental consent is required; if the child is age 5, written child assent is required. No data will be collected from preschoolers in the selected classes who do not have written consent or assent, but these preschoolers will be allowed to participate in intervention activities at their Head Start center. Both male and female preschoolers and caregivers will be recruited.

C.8. RANDOMIZATION AND BLINDING. Following baseline data collection, 6 randomly selected centers will be randomly assigned to intervention or control using a computerized random-number generator. Center directors and teachers will be informed of group assignment. There is no way to completely blind participants

to group; however, having two conditions in different centers minimizes the likelihood of cross-group contamination.[125] Interventionists and caregivers will not be informed of the study hypothesis and will be asked not to discuss the program with others. Data collectors and interviewers will be blinded to the randomization.

C.9. STRATEGIES TO ENHANCE ATTENDANCE AND RETENTION. The research team has demonstrated the ability to successfully recruit and retain participants.[38,106] Retention strategies include: **1)** keeping up-to-date lists of center and participant contacts; **2)** mailing thank-you cards to boost achievement following each step; **3)** using incentives to compensate for transportation and daycare cost in data collection ($40 at baseline and $50 post-intervention); and **4)** sending reminders via telephone calls, text messages, or emails to caregivers who have not completed data collection, weekly tasks, or logged-on to the study's Facebook group for a week.

C.10. INTERVENTION. Rationale for the intervention duration is that 16 weeks provides a reasonable period for behavior habit formation[48] and is feasible for Head Start calenders.[130,131] Additionally, we incorporated feedback from our 10-week prior study indicating that increasing the intervention duration would be helpful.

C.10.1. Caregiver Component. Facebook-based program including 4 habit-formation tasks/wk. (**Table 2**): A Facebook study site was developed in our prior study[38] and will be installed on each intervention caregiver's smartphone, tablet, or computer. All caregivers will be connected via a private Facebook group. *We anticipate >80% will be Facebook users and >90% will have a smartphone with Internet access based on previous literature*[10,11,132] *and our prior study.* To address the unique needs of this low-SES population,[4] the program will **1)** provide caregivers a weekly electronically retrievable flyer containing health information, family fun activities, and behavioral change strategies to help create a healthier home environment, and **2)** encourage interactive positive communication to promote peer support. All program materials will be sensitive to participants' literacy level, low-SES & use of images as confirmed in our prior work. The program has 6 components (**Table 3**).

Table 2. Caregiver Weekly Habit-Formation Tasks via Facebook

Task	Instructions
Get in the kitchen	Post about a healthy meal you made for your family (e.g., *make a recipe of your own OR make chicken noodle soup for your family*).
Make active time family time	Post about physical activity in which you helped child engage (e.g., *take a walk with child, play a family activity game with child*).
Leave a positive comment	Positively respond to one other person's posting (e.g., *Yum! That looks like a delicious meal. Great job.*).
Take a quiz	Reinforce information & strategies learned (e.g., *repeatedly exposing child to novel or disliked food is an effective strategy to deal with picky eaters; true or false?*).

Three face-to-face caregiver meetings: MSU Extension health educators will lead the meetings at Head Start centers (wks. 1, 8, & 16; **Support Letter**) to connect caregivers to each other, offer health information, and discuss behavioral change strategies. To improve attendance and accommodate caregivers' work schedules, each meeting will be held on a weekday and a weekend day at each center. Healthy food taste-testing activities will be offered to expose caregivers to a variety of healthy homemade meals provided by MSU Extension. **Meeting 1**: A healthy, slow cooking demonstration will be offered, and each family will receive a small bag of groceries to facilitate preparation of the demonstrated recipe at home. Alternative cooking ingredients will be discussed to help reduce sugar and fat. Each caregiver will also receive an intervention cookbook containing affordable, slow-cooking recipes, quick-fix recipes, and healthy snack ideas. Reasons for providing a cookbook are: **1)** in our prior study, Head Start caregivers requested "quick fix," affordable but healthy, recipes;[4] and **2)** using a slow cooker to prepare easy but healthy meals is an effective strategy to overcome low-SES parent barriers of lack of time and cooking skills.[4,133] **Meeting 2**: Extension health educators will demonstrate how to spend less and shop healthy, and how to read nutrition fact labels to promote healthy purchasing behaviors. Each caregiver will receive two, durable plastic "MyPlate" adult and child meal-portion plates to guide their proper portion size. **Meeting 3**: Extension health educators will present community healthy eating and PA resources (e.g., farmer's markets, community gardens, nearby parks or

Table 3. Caregiver Facebook-based Program Components

Component	Contents & Instructions
Front Page	Caregiver progress (# tasks completed) will be updated daily on this page.
Complete Tasks	Each Sunday morning, caregivers will receive a notification on weekly tasks and will be asked to complete tasks by midnight the following Saturday. Each Friday morning, caregivers will receive a reminder via Facebook messenger and text messaging to complete the weekly tasks. *For caregivers who have not logged-on to the study's Facebook group for a week, reminders will be sent via text message, phone call, or email aligning with their preferred communication method.*
Past Tasks	Past tasks can still be completed after due date because some caregivers may not be able to complete on time due to illness or other personnel events. The flexibility was highly appreciated by caregivers in the prior study.
Take A Quiz	After completing each quiz, immediate feedback will be provided (e.g., *You bet! Every minute counts. The physical activity goal of 10,000 steps/day can be achieved in sessions: a morning walk, a midday walk, and an evening walk.*).
Encouraging Messages	Messages on parental influence will be posted on the private Facebook group's front page every other day to encourage caregivers to take little steps at a time to help make healthy behavioral changes in the family (e.g., *To the world, you're a mother, but to your child, you are the world.*).
Talk to a Researcher	This will allow caregivers to send private messages to the research team via Facebook messenger if needed to obtain advice on healthy diet and PA.

other free or affordable PA facilities) and provide caregivers a resource manual. Each caregiver will receive a binder including all intervention materials to ensure access to intervention information after intervention ends.

C.10.2. Caregiver-Preschooler Learning. Each week, preschoolers will create two letters using stickers regarding a food or activity presented in the center-based program that they liked or wanted to try at home. Letters will be sent by the PM privately to each caregiver via Facebook messenger every Wed. and Fri. Caregivers will be encouraged to discuss letters with their preschoolers and offer foods and activities desired by preschoolers. They will also be asked to answer two Facebook multiple-choice questions related to the letters each week by Sun. midnight (**a.** *What foods listed in your child's letter did you provide?* **b.** *What activities listed in your child's letter did your family try?*). Caregiver responses to the questions will be summed to indicate caregiver responses to child requests. Each preschooler's letters will be kept in his/her intervention binder with other intervention materials to present to his/her caregiver at Meeting 3. Weekly preschooler activities, with pictures or videos, will be shared with caregivers via the Facebook private group every week.

C.10.3. Center-based Preschooler Component (**Table 4**). Built on previous research,[16,33,38,134-136] preschoolers will receive weekly, age-appropriate, participatory learning[34] co-delivered by teachers and MSU Extension health educators. Session duration will be 20 minutes because children's normal attention span is 3–5 minutes per year of age,[137] and 20 min/session is recommended for preschoolers.[4]

Table 4. Weekly Healthy Eating and PA Program at Intervention Head Start Centers

Theme	Dose	Objectives	"*Eat & Walk My ABCs*" Curriculum*
Healthy eating learning	20 min. Mon.	Increase knowledge	• Learn where food comes from, how its grown, and its nutrition. • Use food cards, costumes, food handheld puppets, and role-playing games.
Taste-testing activities	20 min. Tues.	Expose to healthy foods	• Use senses to understand the foods covered on Monday (how a food looks, smells, feels, and tastes).
Skill training	20 min. Wed.	Improve fundamental movement skill	• Use animal movements to teach fundamental movement skills: balance (e.g., balance on one foot, walk on a line), locomotor (e.g., running, hopping), and ball skills (e.g., kicking, throwing).
Fun physical activity	20 min. Thur.	Increase physical activity	• Use fun activity games adapted from the CATCH early childhood activity box[138] and *Eat Well Play Hard*[139] to practice the movement skills covered on Wednesday. • Reflect on the benefits of participating in physical activity.

*** A nurse expert in child development, a pediatric nurse practitioner, and a Head Start dietitian reviewed and approved the curriculum.**

C.11. CONTROL. Control group will receive usual Head Start activities during intervention period. After post-intervention data collection, each control caregiver will receive all intervention supplies and a mini program including a face-to-face caregiver meeting and 1-week preschooler program. The caregiver meeting will cover contents on alternative cooking ingredients, food labels, and portion sizes.

C.12. TRAINING. To insure intervention fidelity and high quality data, the PI, Co-Is (Robbins & Kerver), and PM will conduct an initial training on study protocol for the whole research team. MSU Extension health educators will receive additional training on the preschooler curriculum. The statistician, Dr. N. Zhang, and Co-I (Dr. M. Zhang) will also train the PM as the data manager and Facebook moderator, respectively. Training manuals will be provided to all research staff.

C.13. INTERVENTION FIDELITY MONITORING & EVALUATION. The PM will monitor the Facebook group daily to record task-completion rates and caregivers' site visits, respond to caregivers' questions and postings, and review records and posted content to ensure proper posting and functionality. Extension health educators will record caregiver meeting attendance and activities, as well as each preschooler's attendance, punctuality, participation, and activities offered for the day in a daily activity log. The PI will communicate with Extension health educators weekly to review objectives, attendance, and intervention delivery dose, and discuss issues and solutions. Head Start teachers will complete an evaluation survey on preschooler program, and caregivers will complete an evaluation survey on caregiver program and preschooler letters (**Appendix A**). Two process evaluators will observe 6 randomly sampled sessions (2/center; 1 session from Extension health educator and 1 session from teacher) to evaluate preschooler curriculum implementation and activity engagement. At post-intervention, individual interviews (**Appendix A**) with 10 randomly selected caregivers will be conducted with the PM and PI to obtain in-depth evaluation of the intervention and future suggestions for improvement.

C.14. DATA COLLECTION & OUTCOME MEASURES (**Table 5, Appendix A**). All outcomes will be assessed at baseline and post-intervention. Height and weight will be measured in a private room in Head Start centers. To improve compliance with wearing accelerometers, an auto text-message reminder will be sent to caregivers every morning at 7AM via the *REDCap* web application maintained by MSU CTSI-BRIC (**Support Letter**). The 24-hour dietary recall will be administered by 4 trained interviewers via telephone[140] on 2 weekdays and 1 weekend day,[141,142] using the Nutrition Data System for Research (NDSR) software developed by the Nutrition Coordinating Center,[143] University of Minnesota. Trained interviewers will also observe the snacks and lunch offered at Head Start centers. Drs. Ling & Robbins, who have completed the 2-day training on NDSR, will assess and assure diet data quality. The Environment and Policy Evaluation and Observation-Self-Report (EPAO-SR)[144] will be completed by each center supervisor and two teachers on a single day to assess each

Head Start center environment, including the physical environment, provisions, practices, policies, training, and education. All other surveys will be completed by caregivers online via REDCap web application. Caregivers will be informed of online surveys via text-message or email. Data collectors and interviewers (blinded to group assignment) will be available by phone or in-person to answer questions.

Table 5. Study Measures

Concept	Measure and Description	# Items	Time	Reliability/Validity
Preschoolers (Aim 1)				
MVPA (min/day)	7-day ActiGraph GT3X-plus accelerometer[145] **Cut-points**: sedentary activity (≤37 counts/15 s), light (38–419), moderate (420–841), & vigorous (≥842)[146,147]	7-day	5 min	Reliability =0.69–0.84[148] *r* =0.66 with observational system[145]
Diet quality (e.g., fruit/vegetable, fiber, sugar/fat)	Intake at Head Start center: dietary observation system on snacks and lunch on two weekdays[149] Intake at home: proxy-reported 24-hour dietary recall	3-day	90 min	ICC =0.99;[149] accurate rate: 95%;[150] good agreement with actual energy intake[151]
Screen Time	NHANES-Physical Activity and Physical Fitness survey[152]	2	1 min	Reliability: *r* =0.63–0.84[153]
Proportion of OW/O, BMI z-score	Calculated from height and weight using CDC growth charts[154] **Height**: Child/Adult Shorr Measuring Board Stadiometer **Weight**: Child/Adult Seca model 874 portable electronic scale In accordance with NHANES measurement protocol[155]	N/A	3 min	Specificity 0.93; sensitivity 0.73[156]
Caregivers (Aim 2)				
MVPA	7-day ActiGraph GT3X-plus accelerometer **Cut-points**: light (0–2689 counts/60 s), moderate (2690–6166), & vigorous (≥6167)[157]	7-day	5 min	ICC =0.97–0.99[158] *r* =0.81 with oxygen consumption[159]
Diet quality	Fruit-vegetable-fiber screener[160]	10	3 min	*r* =0.71 with full Block survey[160]
Screen Time	NHANES-Physical Activity and Physical Fitness survey[152]	2	1 min	Reliability: *r* =0.63-0.84[153]
Proportion of OW/O, BMI	Calculated using (weight *kg*/height m^2)[161] Measures are similar to those used in preschoolers	N/A	3 min	Specificity 0.97; sensitivity 0.42[162]
Knowledge	Knowledge on preschoolers' dietary intake & physical activity[163]	25	5 min	N/A
Feeding Practice Skill	Child Feeding Questionnaire[164] measuring caregiver feeding practice behaviors	33	5 min	α =0.71-0.93[38,164,165] *r* =-0.26-0.53 with child BMI[164-166]
Self-Efficacy	Parental self-efficacy scale[163]	20	4 min	α =0.72-0.94[38,163]
Parental Support	Parental support scale for eating habits and physical activity[167]	12	3 min	α =0.83-0.87[38,167,168]
Parenting Practices	Parenting Style and Dimensions Questionnaire[169] assessing parenting styles: authoritative, authoritarian, and permissive	32	5 min	α =0.64-0.91[170]
Home Environment	Family Nutrition and Physical Activity (FNPA) screening tool[171] assessing home obesogenic environments and practices	20	4 min	Correlated with child BMI[171,172]
Demographics	Socio-demographic questionnaire (e.g., age, sex, race)	12	3 min	N/A
Center Environment	EPAO-SR[144]	1-day	30 min	Related to observational data[144]

C.15. DATA ANALYSIS. Any missing at random (MAR) data will be imputed using procedures suggested by Potthoff.[173] For non-MAR data, a sensitivity analysis will be performed following recommended approaches for continuous and discrete outcomes.[174-177] All analyses will use the intention-to-treat[178] principle. Data analysis will be disaggregated by sex in preschoolers. **AIM 1 & 2**: Mixed-effect models in SAS 9.4 will be used to evaluate the intervention efficacy. Fixed effect predictors will include group, time, groupXtime interaction, and potential confounders such as preschooler sex, race, baseline weight status, and caregiver marital status. The correlation of preschooler outcomes measured over time and dependence due to nesting in the same center or class will be accounted through center- and class-specific random cluster effect. Contrasts will quantify the intervention effects separately at the post-intervention. Holm's method will be used to statistically control for multiple comparisons.[179] Effect size (Cohen's *d*) will be calculated. **AIM 3**: Path analysis will be conducted using EQS 6.2. Model fit will be assessed using root mean square error approximation, Normed Fit Index, and Tucker Lewis index. Chi-square difference test[180] will be used to compare models. Model modification will be made if needed. Feasibility/acceptability/satisfaction will be determined through enrollment, intervention participation, and evaluation survey data. Recorded individual interviews will be analyzed using directed content analysis in ATLAS.ti 8 to evaluate reasons for satisfaction and suggestions for improvement.

Table 6. Method Considerations

Issue	Justification and Strategies
Different participation by Head Start teachers may influence intervention delivery.	• Based on our prior 10-wk study, all six teachers in the intervention classes independently and successfully delivered the last 4 wks. of the program.
Compliance with wearing ActiGraphs.	• We will send daily auto reminders. We will replace broken or misplaced ActiGraphs. Imputation techniques will be used for missing data.
Difficulty meeting recruitment goals.	• We will use Head Start family advocates to help with recruitment. Another center or class will be randomly selected if selected center or class elects not to participate.

Table 7. Timeline for Activities	YEAR 1			YEAR 2		
Months	1-4	5-10	11-12	1-2	3-6	7-12
IRB approval; hire/train staff; prep materials; purchase supplies.	X	X				
Recruit; enroll; baseline data collection.		X				
16-week *"FirstStep2Health"* intergenerational intervention.		X	X	X	X	
Immediate post-intervention data collection.				X	X	
Data entry, cleaning, and analysis; presentations and manuscripts.		X	X	X	X	X

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