The Baltimore Urban food Distribution (BUD) App: Study Protocol for A Food Systems Intervention

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Abstract

Background: Low-income urban communities in the United States commonly lack ready access to healthy foods. This is due in part to a food distribution system that favors the provision of high-fat, high-sugar, high-sodium processed foods to small retail food stores, and impedes their healthier alternatives, such as fresh produce.

Methods: The Baltimore Urban food Distribution (BUD) study is a multi-level, multi-component systems intervention that aims to improve healthy food access in low income neighborhoods of Baltimore, Maryland. The primary intervention is the BUD application (app), which uses the power of collective purchasing and delivery to affordably move foods from local producers and wholesalers to the city's many corner stores. We will implement the app in a sample of 38 corner stores, randomized to intervention and comparison. Extensive evaluation will be conducted at each level of the intervention to assess effectiveness via process and impact measures on suppliers, corner stores, and consumers.

Discussion: BUD represents one of the first attempts to implement an intervention that engages multiple levels of a local food system. The design of the intervention and the evaluation plan of the BUD project are documented here.

Trial registration #: #### (register since not yet recruiting)

Background

Low-income communities in the United States are characterized by low access to healthier food, and consequent food insecurity and diet-related chronic disease (1). Patterns of food access are related to food source types present, including low access to supermarkets/grocery stores and high access to small convenience/corner stores, fast food, and carryout restaurants (2). These food sources tend to primarily carry foods high in calories, fat, salt and sugar, and lack affordable healthier options. Food access has been defined in terms of availability, cost, quality, and location (3). Low-income communities tend to be weak in all of these dimensions, including having low availability of healthier foods, high prices, low quality, and poor location (e.g., within store, not well-displayed). Over the years, evidence has accumulated that the type of nearby food sources is related to consumers' diet and their health, with supermarkets and grocery stores being protective, and small convenience stores being associated with poor diet and negative health outcomes (4).

Most previous work on food access has looked at these dimensions from the perspective of community members (consumers) (5–10). Community-based interventions in the area of improving food access have also largely targeted community members by working in food sources to increase access at the point of purchase, including work in small food stores (11) and prepared-food sources (12). Despite these substantial efforts, limited work has been done to improve access to healthier foods for the food sources themselves.

Why is food sourcing a concern? Low access to healthy food in Baltimore and similar urban food systems is largely due to a distribution gap between small independent food sources and larger wholesalers/distributers. Among small urban corner stores, unhealthy foods and beverages are much more accessible to these stores, due to incentive programs, delivery vehicles, and other formal and informal incentives by suppliers (13). On the other hand, these same small urban retailers have limited access to healthier foods due to the lack of such programs offered by fresh food suppliers (8). Therefore, one approach to addressing the problem of healthy food sourcing/distribution is to implement multi-level food system interventions that can sustainably improve healthy food access for small food retailers – especially in low resource settings.

What is meant by a "food systems intervention"? This is not easily answered. Food systems are complex networks of relationships between different types of actors, including producers, manufacturers, suppliers/distributors, retailers and consumers (14). In our view, a food system intervention would target multiple levels of actors within a food system (e.g., producers, distributors, retailers, consumers) simultaneously, and focus on improving the interactions between these levels.

Digital applications have been used to modify food access (15). During the Coronavirus (COVID-19) pandemic, use of online shopping services doubled (16). Yet the benefits of these services have not been equally distributed. For example, during the pandemic, online shopping services were not available for WIC participants, and only available in some stores for SNAP recipients. It is crucial to improve access to healthier foods among our most vulnerable populations.

The overall goal of the Baltimore Urban food Distribution (BUD) trial is to develop a digital application (app) to improve access to healthier foods and beverages in small corner stores in low-income urban settings, and to generate preliminary findings in support of a full-scale clinical trial.

The BUD trial has three aims:

1. To conduct formative research and engage with key stakeholders to develop a user-friendly BUD app;
2. To implement a randomized controlled trial pilot study of the BUD app, demonstrating feasibility; and
3. To demonstrate impact of BUD in terms of small urban food store stocking and sales of healthier foods.

Methods/design

BUD trial study design overview

The BUD study is divided into three main phases. First, we are conducting formative research to inform the design of a user-friendly interface and experience, as well as develop a stable version of the app. Second, we are employing a randomized controlled trial study design over 8 months to pilot test the app, introducing different features in stages to address identified challenges, and assessing feasibility and impact. Finally, we will show the final app to key

stakeholders in other locations to assess transferability and potential for dissemination. The trial includes thirty-eight small corner stores located in East Baltimore randomized into treatment (n = 19 receiving the BUD app) or comparison (n = 19) groups.

Setting

The BUD study takes place in low-income areas of East Baltimore. Baltimore City has 633 corner stores, 185 convenience stores, 47 supermarkets, 18 farmers markets, 24 urban farm sites, and 6 public markets (17).

East Baltimore is a largely low-income part of the city, representing about one-third of the city's area. In East Baltimore there are 12 supermarkets, approximately 168 corner stores, 88 convenience stores, 2 farmers markets, 9 urban farms, and 1 public market. Of corner stores, about two-thirds are owned and operated by Korean Americans, roughly 15% are operated by Chinese Americans, 5% by Hispanic Americans, with smaller fractions owned by persons of different sociocultural backgrounds.

Most corner store owners locate their stores in areas not being served by supermarkets. Baltimore corner stores typically stock few affordable healthy foods and beverages, instead stocking higher-priced nutrient-poor foods and beverages. In fact, small food retail stores located in predominantly low-income African American neighborhoods of Baltimore have significantly lower healthy food availability index scores than those located in predominantly middle- to high-income White neighborhoods (17–19).

Inclusion and exclusion criteria

Corner stores eligible to participate in the study are located in a low-income neighborhood identified as a Healthy Food Priority Area in East Baltimore (19), are located > 0.25 miles from a supermarket, and are classified as a small store (≤ four aisles, ≤ two cash registers). In addition, the store owner/manager should be English-, Korean-, Spanish- or Mandarin-speaking as a first language, willing and able to order food through a smartphone or internet-enabled device, and willing to attend in-store trainings on use of the BUD app.

Wholesalers and producers are eligible to participate who currently serve Baltimore City (e.g., have wholesale locations and/or attend farmers markets in the Baltimore area), and are willing to use the BUD app.

Consumers will be identified by the store owners as a regular customer of the store (i.e. purchase food items at least once a week in the store), and will be 21–75 years old, live/work within a 0.5 mile radius from one of the participating corner stores, and live in a household of at least two persons. Consumers will be excluded from participation when they anticipate moving out of Baltimore City in the next 12 months or when they are pregnant.

Randomization of corner stores to treatment

Corner stores will be randomized into intervention (receiving the BUD app) or comparison (not receiving the BUD app) groups, following completion of the baseline assessments. The names of each of the 38 corner stores will be written on a separate piece of paper, mixed up, chosen out of a bowl, and alternately assigned to intervention or comparison status. Randomization will be done publicly and documented via photo and posted on team social media sites. Participating stores and interventionists will not be blind to the intervention status due to nature of the intervention design.

IRB approval

This research was approved by the Johns Hopkins Bloomberg School of Public Health Institutional Review Board.
Informed consent will be obtained from all participants (i.e., producers, wholesalers, retailers, consumers).

Formative Research

Extensive multistage formative research has and will be conducted to aid in intervention planning and app development.

Completed formative research: Prior to receiving funding, we conducted initial formative research on improving food access for corner stores, and the acceptability of an app to support this goal (20). Interviews with corner store owners, wholesalers, and food environment experts were conducted to understand the context of food distribution and supply in the city, and to identify features that would make the app acceptable, operable, useful, and user-friendly. A visual mockup, or wireframe, of the app was developed and presented to store owners to stimulate additional feedback. Some of the key findings were: 1) the app needs to provide more than just fresh produce to be considered useful by small store owners; and that 2) delivery will be challenging, and will require multiple options.

Additional formative research: As part of the formative phase of the current study, we are conducting additional formative research to aid in app design.

This includes: 1) conducting case studies of 10 different corner stores, and carefully examining their stocking, ordering and pricing decision making/strategies, methods of payment, etc.
; 2) interviewing 20 community members to assess their priorities for food stocking in local small stores; and 3) developing a prototype of the BUD app which mimics the process of using a completed app – intended to stimulate further discussion of strengths and challenges. Some of the key questions we are trying to answer include: 1) how best to frame the BUD app in a way that encourages cooperation and use of a collective purchasing feature; 2) what payment options are most acceptable; 3) what delivery options will be most acceptable and affordable; 4) what additional features are necessary and/or desirable (e.g., some way to assess and report on consumer demand for specific products); and 5) how do we design a user-friendly interface and experience for corner store owners?

App Development Process

The development of a user-friendly and functional smartphone application depends on the thoughtful design and development of both the "front-end" and "back-end" elements of the application. The front-end includes the user interface, or the screens where the user interacts with the software. The back-end consists of the server that provides data on request, the application that channels it, and the database that organizes the information. There are three types of users for the BUD app, which are Suppliers, Storeowners, and Administrators. Two versions of the app will be designed: the first for Suppliers and Storeowners to use on mobile devices, and the second will be a desktop/laptop aimed admin page designed for Administrators to review analytic results and monitor the app data. The research study team will have access to the app usage data through the admin page. They can check for any communication issues and get feedback on app problems. Additionally, the team can monitor prices and check overall analytics results through the admin page.

User Interface and Experience Design Process

To ensure high usability of the BUD app, this interface will be designed and tested through formative research in partnership with target users as elucidated in the following steps. First, we will design the flow of information and map out the intended experiences we would like users to have while navigating our app. Based on the formative research and user personas, we will design the preliminary structure of how information, content, and features are organized and arranged within the app. We will visualize this organization via a sitemap, a hierarchical diagram showing the structure of content and intended experiences within a website or application. Next, via three qualitative research methods (tree testing, card sorting, and in-depth interviews), we will assess the logic of the sitemap and findability of content within the hierarchy of the tool.

Once the map has been tested and revised, we will then generate initial mockups, called low fidelity wireframes, of the user interface. These show the first sketches of how the interface will be designed. Using these low fidelity wireframes, we will repeat the tree testing (a method to measure findability of content and tools) with potential users. Once we are confident that the design is passing these initial user performance tests, we will then generate and test high-fidelity wireframes (mockups that include all design elements and branding) with target users. The sitemap, branding, low- and high-fidelity mockups are designed via Adobe Photoshop, Illustrator, and XD. Subsequently, these high-fidelity wireframes will be programmed into an app prototype via Adobe XD. A prototype is a clickable visualization of the app that permits likeability, findability and usability testing with target users. Tests will include running 2–3 use cases with potential users where participants are given a typical task to complete using the app. Time to complete task and slow points are documented. Finally, we will convert the user interface from the graphic design of the prototype into an open access package of code (HTML, CSS, and JavaScript) and content that will be uploaded to an open-access code repository and shared with the back-end developer team.

Development of back-end elements:

The back-end of the BUD app will need to be able to communicate with users in real time as well as store, update, and track both purchases and deals made through the app. Additionally, it will need to securely collect and store private, sometimes sensitive, data such as in-app usage statistics (e.g., number of deals, purchases, chats, delivery methods, payment methods). We will also use the app to collect information on the app's usability and likeability, frequency of deals and purchases, and user satisfaction. Finally, we will need to be able to make iterative updates to the app, as user feedback is collected.

To address these needs, we will host the app on Google Firebase. Firebase is an online platform or tool that streamlines the app development process and provides centralized access to, for example, analytics, authentication, databases, configuration, file storage, and push messaging. Another strength of Firebase is that all services are hosted in the cloud, making collaboration and communication across the team easier. A specific URL for the app will be purchased and users will be able to access the app through the link.

Usability testing and Pre-pilot

Once we have a functioning app, we will ensure user-friendliness and functionality through a series of usability tests, culminating in a community "pre-pilot". Initial usability tests will involve providing the app to 8–10 target users (local producers, wholesalers, corner store owners), and asking them to compete certain tasks (e.g., set up a collective purchasing deal, order a food, etc.). Subsequently, one small urban producer and 2–3 small corner store(s) located in East Baltimore will participate in a pre-pilot usability test of BUD prior to full-scale implementation of the pilot trial. The research team will elicit user feedback on acceptability, operability, and perceived sustainability from both the producer and store owner perspectives.

Participants and Evaluation Sample Recruitment

Informed consent will be obtained for the evaluation sample by CITI trained and certified data collectors.

Recruitment of suppliers (producers, wholesalers, etc.)

To facilitate recruitment of food suppliers including, but not limited to, local farmers, wholesalers, and other produce distributors, we will have staff speak with eligible owners and managers asking them to participate in the intervention. The team will create information sheets regarding expectations for participation, such as use of the BUD application, information on delivery methods, and the amount of product required to be uploaded for sale. Recruitment will take place at local farmers markets, urban farms, and other community settings, and via word of mouth.

Recruitment of corner stores

Thirty-eight corner stores located in East Baltimore will be recruited. To facilitate recruitment, we will have bilingual project staff approach eligible store owners. We will distribute flyers with answers to Frequently Asked Questions (FAQ) about the trial written in English, Korean, Spanish, and Mandarin (the most common languages spoken by corner store owners in Baltimore City). Consent forms will be prepared in the four languages, and will clearly explain the benefits and potential risks of participating in the trial, including detailed description of the BUD app, promotional materials, and small initial subsidy (BUDCredit) which will cover some of the purchasing/delivery costs for using the BUD app. We will document reasons for refusal in the study.

Recruitment of consumers

Five consumers will be recruited at each participating study store (n = 190) and will be referred by the store owner or staff as a "usual" shopper (i.e., purchases food items from the store at least once a week). This will also improve likelihood of retention in the study. Furthermore, one of the eligibility criteria of the consumer sample is to not anticipate moving out of Baltimore City for one year. We will conduct interviews at the nearby Johns Hopkins Bloomberg School of Public Health or in other community locations (e.g., recreation centers), following recruitment. A gift card for participation will also facilitate recruitment. We will document all refusals, including reason for refusal.

Intervention Description

The BUD food systems intervention is depicted in Fig. 1. The BUD intervention includes three primary components: 1) the BUD app itself; 2) training of store owners and suppliers in the use of the app; and 3) the provision of promotional materials for use at the point of purchase. *BUD App*: The BUD app will have three main modules: supplier, retailer, and administrator. Key features of the supplier module include registration, entering products onto the app for sale, setting BuddyUp deals, providing delivery options and costs, and tracking and filling orders (Fig. 2). BuddyUp deals use the power of collective purchasing; suppliers can offer a reduced price for selected products that are purchased in bulk by multiple small store owners. Key features of the retailer (corner store) module include registration, identification of products for purchase, review of available BuddyUp deals, a multilanguage chat feature that allows store owners to coordinate group purchases, delivery option selection (including BuddyLift), and options for payment and tracking (Fig. 3). BuddyLift is a delivery option that permits one member of a BuddyUp deal to pick up and deliver the foods to the other members, in exchange for a reduced price. The administrator module is a portal for tracking app usage statistics, and for generating and analyzing user satisfaction data.

Training and Stages of Implementation

The BUD pilot will be implemented in four two-month stages, characterized by the gradual introduction of app features, incremental introduction of food products, presence of an initial subsidy to overcome resistance among store owners, and the promotion of targeted foods and beverages within corner stores (Table 1). In the first two weeks of each stage of implementation of the pilot, in-person training in the use of the new features will be provided to the intervention stores.

Table 1
Stages of implementation of the BUD app during the pilot

BUD Strategies	Stage 1	Stage 2	Stage 3	Stage 4
App Features	BUD App	BUD App + BuddyUp!	BUD App + BuddyUp! + BuddyLift!	BUD App + BuddyUp! + BuddyLift!
Promoted Foods	Low-sugar Beverages	Fresh Fruits and Vegetables	Low-fat Whole Grains, Snacks	Low-sugar Beverages + FV + Whole Grains, Snacks
BUD Credit (for corner stores)	*$100*	*$100*	*$0*	$0

Promotion of Healthy Foods

While the BUD app will support the provision of all foods and beverages to corner stores, special emphasis will be provided on healthier products. We will reach out to local producers of fruits and vegetables, and especially encourage their participation. An incentive system for purchasing healthy foods will be offered to participating corner stores leading to additional deals reducing the costs. Initial subsidies for BuddyUp deals will only be offered for healthier products. Point of purchase in-store promotional materials (shelf-talkers, posters) will be provided to stores to build awareness and generate interest in newly stocked healthier products.

Comparison Group

The 19 comparison stores will be introduced to the BUD app following completion of post-intervention data collection.

Evaluation Measures

The BUD pilot trial will be evaluated pre- and post-intervention, at the supplier (producer, wholesaler), retailer (corner store), and consumer levels (Table 2). Process evaluation measures will assess reach, dose delivered and fidelity of intervention implementation according to set standards. Participant retention and follow-up will be promoted by regular communication with producers, wholesalers, and stores. This will be in the form of in-person visits to stores, communication via the app/telephone calls, and trying to resolve any issues that have led to a need or indication to drop out of the study.

Type of Data Collection	Time of Data Collection	Level of Data Collection
Feasibility Metrics: Acceptability, operability, perceived sustainability and user satisfaction with the BUD app	During intervention (multiple measures), Post-intervention	Producer, wholesaler, retailer
Stocking of healthy and unhealthy foods	Baseline, During intervention, Post-intervention	Retailer
Process Metrics: Reach, dose delivered, fidelity	During intervention (multiple measures)	Study Team
Sales of healthy and unhealthy foods	Baseline, During intervention, Post-intervention	Retailer
Purchasing of healthy foods	Baseline, Post-intervention	Consumer
Consumption of healthy foods	Baseline, Post-intervention	Consumer
Financial costs and benefits from perspective of suppliers	Post-intervention	Producer, Wholesaler, Supplier
Prices of healthy foods	Baseline, During intervention, Post-intervention	Retailer

Retailer measures

Impact data for corner stores will be collected using a modified version of our Store Impact Questionnaire (SIQ) to assess store characteristics, self-reported BUD app usage, corner store owner psychosocial characteristics (self-efficacy, intentions, expectations), sales (last 7 days) and prices of promoted foods and beverages. In addition, we will introduce a Point-Of-Sale (POS) tablet with software to record on-the-go unit sales of targeted foods and beverages (21). Retailer process measures will center on the number of stores using the app (reach), which features are used (dose) and how often the app is used, as well as what types of functions they use in the application (i.e., BuddyLift or chat feature) (feasibility) and number of orders placed.

Supplier measures

Participating producers and wholesalers will be assessed pre-, post-, and during implementation of the pilot. Impacts will examine indicators such as number of 1) orders from corner stores received using the app, 2) BuddyUp deals initiated, and 3) units of promoted foods and beverages sold to/delivered to corner stores. Process measures will include any use of the app (reach), frequency and duration of use (dose), number of orders fulfilled, and number of BuddyUp deals offered (fidelity).

Consumer measures

We will assess consumer outcomes using a modified version of our Adult Impact Questionnaire (AIQ) that we have used in previous studies in Baltimore (22). This instrument will collect sociodemographic information and food purchasing behavior such as how many times a product was bought and from which type of store (i.e., corner store, grocery store, urban farm, etc.).

In particular, we will assess purchasing of promoted products from participating corner stores.
The AIQ also requires data collectors to measure the height, weight, and body fat percentage of consumer participants. The Adult Block Food Frequency Questionnaire (FFQ) will estimate adult consumer food intake and nutrient consumption (e.g., total energy intake, total fat, added sugar, sugar sweetened beverage and fruit and vegetable intake) (23).

Process evaluation measures

We will record delivery of the intervention by study team members during the intervention phase. Reach measures include the number of visits or consultations with retailers or suppliers per week. Dose standards are based around the amount of time spent interacting with retailers and suppliers and fidelity standards capture the opinions on BUD from retailers and suppliers. Team process evaluation measures will be recorded using a process evaluation data form created via REDCap and collected on a tablet during a site visit (24, 25).

Data Management:

All collected data will be reviewed by two different trained research assistants for completeness. For data collected via paper forms, research assistants will de-identify and enter data into password-protected Microsoft Access databases.

Sample Size and Statistical Methods:

Sample size calculations for impact on corner stores were based on the analysis of a simple difference in change in mean Healthy Food Availability Index (HFAI) scores. We used the reported mean change in HFAI in control and intervention corner stores from the previous B'more Healthy Communities for Kids trial (26), positing that the subsidy and price incentives combined with the introduction of the app would create a greater change in HFAI than in the BHCK trial. Ultimately, calculations for a two-sample comparison of means assuming a difference in healthy food availability (HFAI) of 6 points, variance of 24, intraclass correlation of 0.0001, type I error of 5% and power level set at 80% led to a total sample size of 34 stores with 17 per arm. Two stores were added to each arm of the study to account for possible attrition, leading to the final sample size of 38 stores.

This trial is not powered to show impact at the consumer level, but is designed to provide adequate precision of estimates to power a future clinical trial at the consumer level. By examining correlations of outcomes within stores over time, between participants (customers) within stores, and within participants over time, these data will allow us to assess clustering, permitting us to estimate the intraclass correlation coefficient (ICC) and precision around it. The consumer sample size is intended to obtain an estimate of effect size and the variance in food consumption, purchasing, and body mass index, in order to plan a larger clinical trial.

Data Analysis

Feasibility analyses

Feasibility analyses will focus on assessing economic and cultural acceptability, operability and perceived/planned sustained use of the BUD app, including barriers and enhancing factors. From the corner store owner, wholesaler, and producer perspectives, acceptability will be assessed according to whether the new products are perceived to be in demand, profitable, easy to obtain and store. Operability will be assessed primarily in terms of the BUD app, such as whether store owners indicate (and demonstrate) that they can and do continue to use the different features of the app. Perceived sustainability will be assessed in terms of whether store owners (and other users, such as wholesalers and producers) indicate that they plan to continue to use the BUD app, how much, and for what purposes. Textual data will be coded by trained staff using a codebook that emphasizes these feasibility constructs. Qualitative analysis will center on providing contextually rich descriptions of each aspect of feasibility, and describing some of the key sources of variation (e.g., by store size, owner ethnicity, etc.). Analysis of the qualitative consumer interviews will focus on identifying those healthier products that would be most acceptable to them in terms of demand, cost, taste and other similar characteristics. This analysis will also identify best in-store strategies to promote healthy foods to consumers.

Process Evaluation Analyses: We will conduct a detailed quantitative process evaluation (in terms of reach, dose delivered, and fidelity), and results will serve as additional measures of feasibility, particularly in terms of establishing operability and potential sustainability. Three primary process dimensions will be assessed: reach, dose delivered, and fidelity – each will likely have multiple measures – and standards will be set for each measure to monitor quality of intervention implementation. We will set standards to monitor quality of intervention implementation for the reach, dose, and fidelity measures, and revise these standards based on the experience of the R34 trial for the planned future full-scale trial.

Feasibility will also be assessed via analysis of user satisfaction responses collected during operation of the BUD app, as well as in terms of responses to the open-ended questions that will be part of the process evaluation measures.

Pilot Trial Store Impact Data Analyses

Using direct observation-based stocking data, a healthy food availability index (HFAI) score will be calculated, and we will initially examine the difference from pre- to post-intervention comparing intervention and control stores. We will also look at change in availability and sales of specific promoted product categories from pre- to post-intervention at each specific phase of intervention. Mixed-effect models, treating the stores as a random effect, will be used to evaluate the effect of the intervention on availability and sales of healthful food and beverage scores comparing corner store intervention and comparison groups, and adjusting for covariates, such as store size and food stocking at baseline. We hypothesize that prices of some promoted foods and beverages will decrease given promoted foods/beverages will be subsidized during the first two phases of the intervention, as compared to baseline (if stocked at baseline). Furthermore, we will conduct additional tests to see if a pass-through price effect occurred related to the initial subsidy. Since the subsidy is short term (just phases 1 and 2 of the intervention), relatively small, and intended to generate initial usage of the app, we do not anticipate a significant price effect.

Pilot Trial Adult Consumer Impact Data Analyses

From the adult consumer impact questionnaire (AIQ) on purchasing frequency of promoted foods and beverages (i.e. fruit and vegetables, low-fat snacks, low-sugar beverages, whole grain foods), and using the Block FFQ data on the intake of the same products, we will compare the change in purchasing and consumption among consumers of intervention stores to the comparison store consumers. These analyses will be adjusted for potential confounders, such as age, sex, income, participation in food assistance programs, and other household covariates, when appropriate. We will use linear mixed-effect models with individual and store random effects to identify potential predictors of participation. We hypothesize there will be a trend toward increased purchasing and consumption of healthy promoted foods and beverages among intervention consumers compared to consumers that are sampled from comparison stores.

Economic analyses

We will conduct economic analyses from three perspectives. First, we will study the economic impact of adding BUD from the store's owner perspective. In this approach, we will consider a marginal analysis approach where we will evaluate the sequential benefits of progressively adding the app to cover a larger proportion of transactions versus the marginal costs of an incremental adoption. We will also look at the adoption from a one-time decision analysis where we will compare the total stream of benefits to the total costs of developing and adopting BUD. We will pay particular attention to fluctuations in profits, and cost efficiency gains in terms of reduction in costs of repeated transactions as well as other potential operational gains. Second, we will consider an analysis at the community member level, where we will examine the benefits and costs to the consumers of introducing the app. In this case, we will consider reduction in prices, availability of healthy items, and if possible, changes in quality of products. Finally, we plan to study how psychological constraints may influence the individual judgement of adopting the technology (framing of the photos of the food, simplicity of use, size of the consequences of errors, social norms, fear to change previous practices, etc.). This broader approach to studying the economic implications of adopting the technology is important for understanding its potential sustained use.

Upon completion of data collection, entry, and cleaning, the data analysis team will meet to discuss missingness and build an appropriate model for imputation, including identification of variables for imputation (i.e., missing data that fit the assumptions of missing at random (MAR)), and auxiliary variables that should be included in the imputation model. We will use a method known as fully conditional specification (FCS), also referred to as multiple imputation by chained equations (MICE), which allows for imputation on a variable-by-variable basis, cycling iteratively through univariate models for each variable conditioned on all other variables in the model.

Discussion

We describe the development and piloting plan for the Baltimore Urban food Distribution (BUD) app, a novel food systems intervention to improve the distribution of food to small urban corner stores from local producers and wholesalers. There are many other interventions aimed at improving the food system (sugar-sweetened beverage (SSB) taxes, Baltimore Healthy Stores), but almost all of these focus on just one level of the food system (e.g., policy, food stores) and employ a single strategy (e.g., raising the prices of SSB) (27, 28). BUD directly impacts multiple levels simultaneously (retailers, suppliers and consumers), and does so by building networks between retailers, linking them to suppliers, integrating different types of suppliers, and employing multiple supportive strategies (collective purchasing, shared delivery).

The BUD intervention is designed to target the specific food access needs and constraints of low-income urban communities.

It is based on our nearly 20 years of experience working with local retailers to improve the Baltimore food system (26, 29–35).
Many challenges exist that we hope to address in this pilot trial. The first is one of acceptability. Will small store owners use the app; and what features will encourage their use? Once the subsidy is gone will they keep using the app? Store owners' gains for adopting the app must be greater than costs; and these net benefits must be recurrent for individuals to adopt the new technology over a sustained period. Personalized training in the use of the app may be helpful, but will be difficult to sustain if use of the app expands. We will get an idea of sustainability during phases 3 and 4 of implementing the app, when no subsidy is provided.

Will small store owners participate in collective purchasing and shared delivery features of the app? Such participation is crucial, as it drives the cost-saving elements of the app. A related consideration is financial sustainability and expansion. BUD could potentially become self-supporting. A challenge will be how to make it responsive to public health priorities and to focus on supplying mainly healthier foods – we do not want BUD to become another way to get chips and candy into urban corner stores.

Our future plans, if this pilot is successful, include a full-scale implementation in multiple cities. There are multiple challenges in "scaling up", including the need to develop similar relationships in new places, evaluating assets and needs in new settings, making adaptations, and identifying resources. However, it is highly likely that some interventions, including the current one, may be adaptable to a variety of different urban areas, particularly those urban areas that share several similar assets and challenges. Adapting a food system intervention to other urban food environments could save time and resources.

A decentralized approach to scale up can also be pursued, in which local public health researchers, working with software development teams, can develop local versions of the BUD app, tailored according to the needs of their communities. To facilitate this scale up, we would complement our dissemination of the BUD project protocols and findings with publication of the actual software components that drive the BUD app. As noted earlier, this would be done through the widely used GitHub software repository along with online tutorials that would provide software development teams with the technical details, including step-by-step implementation procedures, that are needed to make BUD operational. We would also highlight the BUD back-end and front-end components that could be modified to suit the needs and requirements of their local users.

Abbreviations

BUD
Baltimore Urban food Distribution app

Declarations

References

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Figures

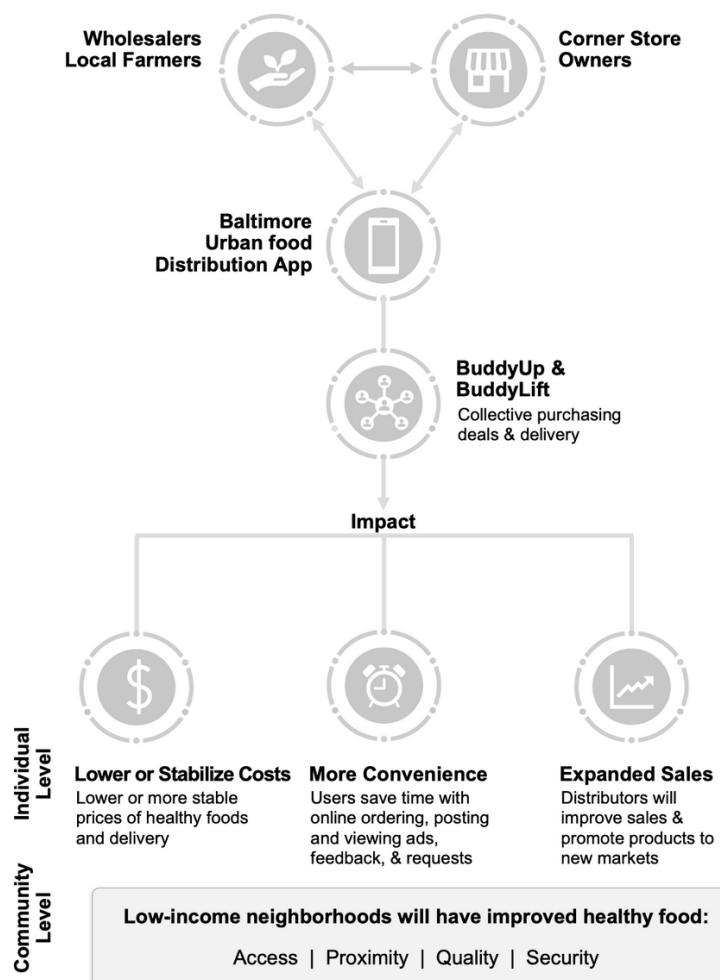Figure 1. Baltimore Urban food Distribution app Conceptual Framework

Figure 1

Baltimore Urban food Distribution app Conceptual Framework
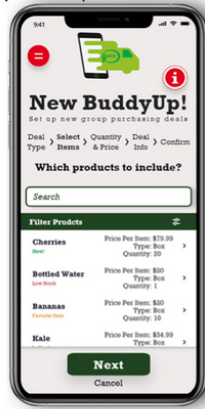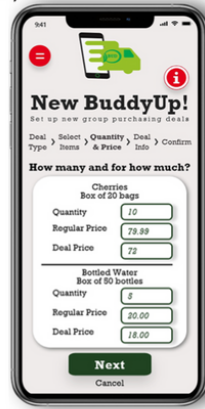
Figure 2

BUD Producer & Wholesaler Screen Mock-Ups
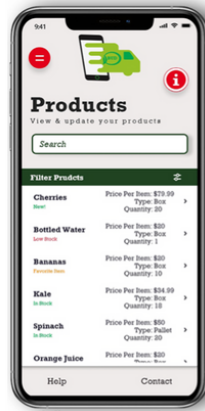
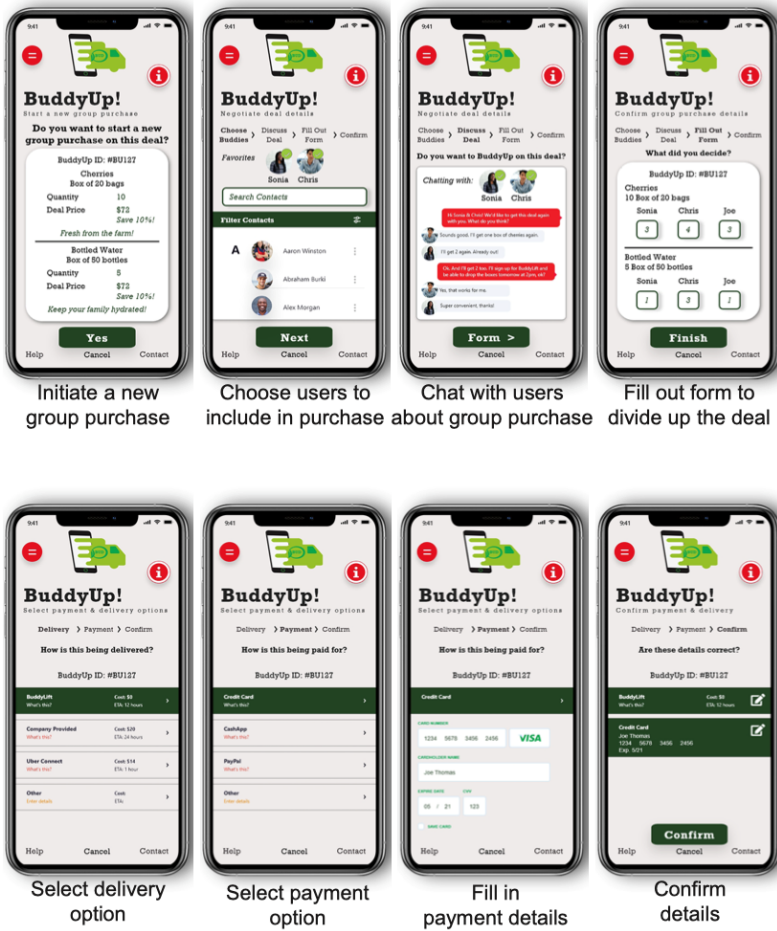A. Participate in BuddyUp! Deal

Figure 3

BUD Corner Store Owner Screen Mock-Ups

Supplementary Files

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- AdditionalfileSPIRITBUDprotocolpaper.docx
- BUDProtocoladditionaltableforSPIRIT.docx
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