

Study Title: Evaluating household food behavior with a smartphone app

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IRB Review Plan

This is a subcontract project with Ohio State University as the lead institution and Pennington Biomedical Research Center (PBRC), part of the Louisiana State University system, as the subcontractor who will conduct the human subjects research. PBRC will pursue the research outlined herein, and this research will only be conducted at PBRC with only de-identified data being shared with the OSU investigators.

Objectives

Long-term Goals and Specific Objectives

Our *long-term goal* is to improve global sustainability and enhance food security while improving the competitiveness of the U.S. food system by reducing U.S. household food waste. To reduce household food waste, we must first improve the accuracy, convenience and standardization of its measurement so that evaluations of waste reduction initiatives have more statistical power, less statistical bias, less measurement error, and greater representativeness of targeted populations. Such improved evaluative capacity can stimulate research and program assessment, which then guides prioritization of emerging private and public programs and policies aimed at reducing household food waste.

Specific objectives include:

- (1) **Development of FoodImage, a smartphone app** that measures household food waste and food-waste-related behaviors,
- (2) **Assess differences in the accuracy, time burden and perceived convenience** of measurements taken with the FoodImage app versus the current state-of-the-art household food waste measurement approach (a pen-and-paper diary), and
- (3) Use the FoodImage app in a pilot **randomized controlled trial** designed to evaluate the effectiveness of reducing household food waste through **behavioral nudges** in the form of personalized feedback about food waste levels and household-specific reduction goals.

Background

About one-third of U.S. food is wasted with two-thirds of this waste attributed to consumers. The United States proposes to cut food waste in half by 2030 and, while many policies are available, those that change consumer waste behavior will be integral to achieving U.S. goals. However, we lack quality data about household food waste because popular data collection methods (diaries and waste stream analyses) suffer major shortcomings. Hence, rigorous evaluation of consumer interventions prove elusive.

We propose to improve the accuracy and convenience of household food waste measurement so that consumer food waste program evaluations yield more power, less bias, less measurement error, and greater representation of targeted populations. We will improve measurement via the development of the **FoodImage smartphone app**, a technology leveraging the investigators'

expertise in creating and deploying apps to measure food intake and deliver nutritional interventions in free-living household conditions. We will validate the app against weighed waste in a controlled laboratory setting and then deploy the app in free-living conditions as part of a pilot randomized controlled trial to evaluate if **behavioral nudges** in the form of personalized feedback and goals can reduce household food waste.

The study will yield an app ready for future study deployment while analyses of the data will inform rapidly evolving policy discussions concerning optimal approaches to reduce food waste. These outcomes align with program priorities to understand the economics of food waste and to use behavioral economics to address consumption behavior.

Rationale and Significance

Countries around the world have resolved to reduce food waste in order to help achieve global food security and sustainability goals [1-6]. About one-third of global edible food is lost or wasted annually [7] while the global production of uneaten food generates greenhouse gas emissions estimated to exceed those created by the third largest greenhouse gas emitting nation [8]. The Organization for Economic Cooperation and Development identified reducing food waste as an avenue to increase the availability of food [9], while the Obama administration announced in September of 2015 a first ever food waste reduction goal for the United States of 50% by 2030. While present in the entire post-harvest supply chain, food waste at the retail and consumer levels is particularly prevalent in the United States. In 2010, 133 billion pounds of edible food at the retail and consumer levels went uneaten (1,249 calories per person per day) with about two-thirds of this waste attributed to consumers [10]. This represents not only a significant waste of resources, but also substantial negative environmental externalities as about 95% of food waste enters U.S. landfills. Food waste is the largest source (35.2 million tons) and the most deleterious component (in terms of greenhouse gas emission) of U.S. municipal solid waste [11-14].

Because so much food waste is attributable to consumer residential behavior (about 47% according to BSR's 2013 analysis), it is critical to articulate, evaluate and prioritize the numerous possible household food waste intervention strategies. ReFED [15] articulates several categories of possible household interventions ranging from labeling interventions to packaging alterations to general education campaigns, where each category is likely to give rise to several variants requiring evaluation. While it is encouraging that the World Resources Institute (2016) has issued global standards for food waste accounting and reporting, a recent review of consumer food waste studies [16] reveals few published studies measuring individual level food waste created by U.S. consumers [17] [18], and these studies focus on consumer behavior in all-you-can-eat buffet settings that may yield limited insight for other dine-out or eat-in settings. Quality data is lacking for the United States.

Inclusion and Exclusion Criteria

Inclusion criteria are: 1) age 18-65 years, 2) body mass index 18.5 – 50 kg/m², based on self-reported height and weight, 3) conducts at least 75% of shopping and 75% of food preparation for the household, 4) household consists of two or fewer people including the responding subject, 5) have an email address that is used regularly, and 6) have an apple ID and cell phone that is

used regularly. **Exclusion criteria** are: 1) not able to use an iPhone, 2) refusal or unable to use a smartphone app or pen-and-paper diary to collect food waste data in the lab during Phase 1, 3) refusal or unable to use the smartphone app to collect data for approximately 14 days in free-living conditions, and 4) households that purchase groceries less than one time per week. Participants must use their own iPhone during the study and need to acknowledge that data will be used during the course of the project; hence, data charges are possible as a result of participation (the FoodImage app will be similar to PBRC's SmartIntake app, which uses very little data during data collection).

Number of Subjects

24 participants are expected to complete Phase 1. All 24 that complete Phase 1 plus an additional 20 adults will complete Phase 2. Pennington Biomedical Research Center employees are eligible to participate.

Recruitment Methods

Subject Recruitment

After IRB approval is received, a sample of 44 adults will be recruited from the Baton Rouge, Louisiana area **to participate in Phase 1 (n=24) and Phase 2 (all 44 participants)**. Recruitment will be completed by PBRC's Recruitment Core. The Recruitment Core manages all community outreach and recruitment services for human research studies at PBRC, such as screening all incoming calls to determine study eligibility; assisting in partnership development, specifically with local community groups, physicians, and healthcare facilities; and serving as the first line of contact for all human research study participation. Incoming calls are directed to a call center that is operated by 3 full time recruiters and is equipped with a Uniform Call Distributor (UCD) system. A UCD system expands the capability of a traditional phone system and allows multiple individuals to call simultaneously and be directed to the next available recruiter. The core utilizes an electronic message tracking application that tracks the outgoing phone call activity and a "smart" electronic phone screen system that screens potential participants upon initial phone contact and seamlessly matches them to alternative studies when deemed ineligible for the original study that the participant called. In 2012 the core launched a new web-screener for participants to be able to go on-line, choose a study that are interested in and complete a preliminary screening. The system is able to tell the participant upon completion whether they are eligible at that point in the screening process and if they are ineligible the screener will alert them to other studies that they be eligible for and at that point could continue to screen for those studies. If the participant is eligible they are then contacted by a live recruiter to complete the screening process and schedule their first screening appointment if they are eligible. We anticipate 132 phone screens to enroll 44 participants (3:1 ratio). Immediately after participants are consented and enrolled, they will complete the following questionnaires:

- a) Food Environment Questionnaire (Appendix 1) - this questionnaire assesses how many people are in the household, how involved the participant is in food preparation, how much is spent on food, where foods are purchased, etc.
- b) FoodImage Waste Disposal Methods Questionnaire (Appendix 2) - this questionnaire details how food is discarded in the participant's household. Specifically, if foods are

thrown in the trash, discarded by composting, saved, put into garbage disposal, fed to pets, donated or discarded in other ways.

Study Timelines

Participants will complete the procedures as noted in the Procedures section. The study involves one visit to Pennington Biomedical for Phase 1. Phase 2 will be completed remotely for those that completed Phase 1 and may be asked to make an additional visit to Pennington Biomedical at approximately the midpoint of Phase II. For those that did not complete Phase 1, participants will come to PBRC for an initial visit for consent and training and they may be asked to make an additional visit to Pennington Biomedical at approximately the midpoint of Phase II.

It will take up to 1.5 years to recruit participants and have them complete Phase 1 and Phase 2. It will take approximately 3 years to complete the study and all data analyses.

Study Endpoints

The primary endpoint of this study is food waste, measured with the FoodImage app in controlled and free-living conditions and measured with food records only in controlled conditions.

Secondary endpoints include satisfaction with the FoodImage app and food records and food purchase records.

Procedures Involved

Phase 1: Testing the FoodImage App and Pen-and-paper Records with Consumers in a Laboratory Kitchen and Dining Setting The accuracy of the FoodImage app and food records under controlled conditions, and satisfaction with both methods via questionnaire and focus groups and/or cognitive interviews, will be quantified in the Phase 1 lab-based study. The criterion measure will be directly weighed food waste. Food waste will be simulated in the laboratory for this phase of the research by preparing several combinations of uneaten or unused food in different amounts and of different types.

Prior to simulated food preparation and food waste, participants will be trained on how to use the FoodImage app and the pen-and-paper food records. This training includes the following:

- a) Food intake and waste form (Appendix 3) - this pen and paper diary allows participants to track food details including type of food and preparation style, type of meal, how much is consumed and discarded, and other specific details about food items during preparation and waste.
- b) Guidelines for entering food descriptors into the FoodImage app (Appendix 4) - this is a general information sheet the participant can take home to review as needed when entering food into the app. It supplements in person, hands on training that is received in the laboratory setting.
- c) How much is a serving (Appendix 5) - this is a quick reference guide that assists participants in accurately estimating serving size of foods.

The following conditions will be simulated in the PBRC's Ingestive Behavioral Lab's (IBL) Prep Kitchen, and participants will be asked to use each method (the FoodImage app and food records) to perform the following tasks:

- a. Measure food waste created during food preparation with foods that include edible and non-edible food waste. The food waste will also differ in its ability to be composted, discarded via a disposal, or disposed of via garbage/landfill.
- b. Measure food waste created during simulated eating conditions with different amounts of plate waste (participants will not consume food). The plate waste will differ in its ability to be saved as left-overs or disposed of via composting, garbage disposal, fed to pets, or garbage/landfill.
- c. Measure food waste created during simulated cabinet and refrigerator clean-outs (purges) due to the discarding of spoiled foods, foods that exceeded the expiration date, foods that were edible but will not be eaten, left-overs that were not eaten, etc.
 - Measurements from activities a, b, and c will be collected by participants with both the FoodImage app and the pen-and-paper diary, while lab personnel directly weigh foods to provide the criterion value (i.e., the basis for establishing a method's accuracy and validity). The order of using the FoodImage app vs. food records will counterbalanced across participants.
- d. Logging simulated food purchases from grocery stores and restaurants, including images of foods purchased and scans of receipts, barcodes, price look-up (PLU) numbers, etc. These data will be collected to determine the extent to which receipt scans and other methods are a viable method to quantify and value food purchases to calculate the dollar value of discarded foods.
 - These data are not primary as regional average prices for foods can be used to estimate the value of discarded foods.

Participants will complete a survey (Appendix 6; FoodImage User Preference Survey – Phase I) to report their satisfaction with the FoodImage app and the pen-and-paper diary. This survey evaluates how much participants liked the two types of recording and includes questions about ease of use and satisfaction with both methods. The survey was modeled from surveys developed to assess satisfaction with the Remote Food Photography Method (RFPM) SmartIntake™ app [19, 20]. This is followed by either a small focus group or a cognitive interview (cognitive interviews will be conducted when only 1 participant can complete Phase 1 at a given time) to obtain qualitative data from participants about each method.

Phase 2: Randomized Controlled Trial of Behavioral Nudges to Reduce Household Food Waste

Phase 2 will occur in participants' natural environment (free-living conditions) and will involve the 24 participants from Phase 1 and at least 20 more participants (44 total). Those participants that did not complete Phase 1 will make a visit to PBRC to provide consent and complete the Food Environment Questionnaire (Appendix 1) and Waste Disposal Methods Questionnaire (Appendix 3). They will then receive training on use of the FoodImage app (see Table 1, Schedule of Procedures), including Appendix 4 (Guidelines for Entering Food Descriptors into the FoodImage App) and Appendix 5 (How much is a serving). Participants will be asked to use the FoodImage app to capture data on food purchases, food waste that occurs during food preparation, food waste that is present after eating, and food waste from stored food purges.

During collection, subjects will record the source, reason and destination of all food waste on the app.

In Phase 2 all participants will capture baseline food waste levels for approximately 7 days before meeting with research staff for additional information and training (either in person at PBRC or via video call or phone call). After the meeting all participants will continue to use the app to record food waste for approximately 7 additional days. During the meeting respondents will be randomly assigned (1:1 ratio) to either:

1. Control, who receive follow up training about how to use the app to capture all food waste and receive information about stress reduction.
2. Treatment, who receive follow up training about how to use the app to capture all food waste and receive information about how to reduce household food waste adapted from current consumer campaigns (e.g., Food: Too Good To Waste Implementation Guide and Toolkit, EPA 2016).

At the end of Phase 2, participants will complete two brief surveys. The Food Waste Tip Questionnaire (Phase 2) (Appendix 7) gathers information on how satisfied the participants were with the tips and how helpful they thought the tips were in reducing food waste. The User Satisfaction Survey (Phase 2) (Appendix 8) gathers information on the ease of using FoodImage app for capturing information about food waste at all stages of food purchase, prep, and consumption.

Randomization will occur via Greevy et al.'s [21] optimal multivariate matching before randomization technique. A matching algorithm (e.g., Mahalanobis) creates pairs balanced on hypothesized drivers of food waste and then one member of each pair is randomly assigned to treatment. Greevy et al. (2004) find this technique can provide the same statistical power as standard practice (unmatched randomization) with a sample size that is 7% smaller. Bruhn and McKenzie [22] provide guidance to optimally analyze data generated by such pairs and find such a pre-randomization matching protocol to work well among smaller samples. Key matching variables will include household size (2 household members vs. 1), sex, and participation in Phase I. The randomization codes will be derived by the study biostatistician and delivered to the interventionist who will inform the participant of their assignment.

Both groups will expect to communicate with researchers on approximately day 8. Both groups complete a survey after approximately day 14 that assesses satisfaction with the app and allows for open-ended feedback and suggestions about the app (Appendix 8) and, for the treatment group, about the perceived efficacy of the food waste reduction tips (Appendix 7).

Table 1. Schedule of procedures.		
	Focus Group / Phase 1 (lab-based)	Phase 2 (free-living)
N	24	44
Consent and completion of questionnaires regarding food environment and waste disposal methods (Appendices 1 and 2)	x	X (*only for those that did not complete Phase 1)
Training on use of the app and modified food records to capture food waste data (Appendices 3-5).	x	X (*only for those that did not complete Phase 1; also, participants who did not complete Phase 1 will not use food records)
Collection of data in the laboratory and User Preference Survey (Appendix 6)	x	

Use of the app in free-living conditions for approximately 14 days of data collection.		x
Receive additional training and information via in-person or phone (or similar method) meeting with staff after using the app in home for approximately 7 days.		x
Satisfaction Survey – FoodImage Food waste Tip Questionnaire (Appendix 7) for Intervention group only); FoodImage User Satisfaction Survey (appendix 8) for all		x (end of the free-living phase)
* Those participants who came to PBRC for Phase 1 will not need to return for Phase 2 for initial training, but may be asked to return after approximately 7 days of in home use of the app. The Surveys will be sent to PBRC via mail or email.		

All named personnel are current in their human subject training and have significant experience with the IRB approval process and field experiment designs. The staff involved in communicating with subjects are counselors who are registered dietitians and behaviorists trained in behavioral counseling (with minimally a Masters in psychology).

Data and Specimen Management

Analysis

Phase 1 analysis objectives include:

- 1) Determining if food waste measured with the FoodImage app is equivalent to the criterion value (directly weighed food waste) for each source (plate waste, food purges, etc). Error (the difference between food waste measured with the FoodImage app and the criterion value) will also be quantified for each source.
- 2) Determining if food waste measured with the pen-and-paper diary method is equivalent to the criterion value for each source. Error will also be quantified for each source.
- 3) Determining if the error from the FoodImage app is smaller than error from the current prevailing method (pen-and-paper diaries).
- 4) Determining if satisfaction ratings differ significantly between the app and the diary approach.
- 5) Determining if the amount of time respondents took to complete measurements differed between the app and diary approaches.
- 6) Qualitative assessments by respondents of the desirable and undesirable features of the app and food records.
- 7) Determining if the variance of waste measures differed between the app and diary approaches.
- 8) Assessing the accuracy of receipt data as captured by participants using the app.

Power Analysis. We base our power analysis on plate waste data gathered from previous research conducted at PBRC [20]. With an N of 24, we are powered to detect equivalence within

20 grams with power of 0.80 and alpha of 0.05. Also, *t*-tests to determine if the error from the app (weighed food waste minus estimated waste) differs significantly from the error from the diary method is powered to detect differences as small as 12.8 grams.

It is **hypothesized** that food waste will be equivalent (within 20 grams) when measured with the app vs. direct weights of food waste, while food waste measured with the diary method will not be equivalent to directly weighed food waste. It is also hypothesized that the error from the app will be significantly smaller than error from the diary method.

Phase 2 analysis objectives include:

- 1) Quantifying baseline distributions for total weight of household food waste
- 2) Determining the effectiveness of the behavioral nudge in altering
 - a) Total daily weight of all household food waste,
 - b) Total daily weight of each source of household food waste by occasion, including
 - i) plate waste,
 - ii) food prep waste,
 - iii) purge waste,
 - c) Total daily weight of each source of food waste by food type (e.g., dairy, meat, fruits, etc.) and by macronutrient,
 - d) Daily percent of served food that is wasted, and
 - e) Total amount of food purchased by weight and value.
- 3) Quantifying satisfaction levels with the FoodImage app as measured in Appendix 6 (FoodImage User Preference Survey) and Appendix 8 (FoodImage User Satisfaction Survey),
- 4) The demographic, household and attitudinal factors measured in Appendix 1 (Food Environment Questionnaire) related to
 - a) Effectiveness of the behavioral nudge intervention in reducing food waste generated and all subcomponents listed above, and
 - b) Satisfaction levels with the app as measured in Appendix 8 (User Satisfaction Survey).

Withdrawal of Subjects

Subjects may be withdrawn from the study if they are non-compliant with study procedures and they will be notified of their withdrawal via telephone or mail.

Subjects may voluntarily withdraw from the study at any time. No additional data will be collected and they will be considered drop outs in the study.

Risks to Subjects

This study involves no greater than minimal risk. The main risk is breach of confidentiality, and the PBRC team will work to minimize this during data collection, handling, and analysis.

Potential Benefits to Subjects

Participants may benefit by increased awareness of their food waste behaviors.

Setting

All research procedures will be conducted at PBRC and in participants' natural environment.

Resources Available

PBRC has all the necessary equipment needed to undertake and execute the proposed research project successfully. All investigators and staff have offices or cubicles. Investigator offices are each equipped with a desk, chair, filing cabinets and shelves, telephone with voice mail, printer, and access to a photocopier and fax. Computers are equipped with software for statistics, data management, and word processing, and computers are connected to the PBRC mainframe with internet access and email access through Outlook Express. Information Technology (IT) provides full technical support to all members of the faculty and staff. PBRC has all the technological equipment and staff needed to conduct the present study. These information technologies assure efficient data handling and optimal communication among the investigators and the team.

Compensation

Participants will be compensated \$30 for successful completion of Phase 1 and \$175 for successful completion of Phase 2 (maximum compensation = \$205). All compensation and recruitment success figures are based on historical averages from previous PBRC studies with similar respondent burden.

Confidentiality and Provisions to Protect the Privacy Interests of Subjects

Participants' records will be kept confidential to the extent allowed by law. Only Drs. Corby Martin, John Apolzan, and Brian Roe, the Ohio State University research team, and the PBRC research team will have access to the information participants provide. All data provided to the Ohio State University team will be de-identified. Information may also be shared with necessary Institutional Review Boards and Offices for Human Research Protection (OSU Institutional Review Board, Pennington Biomedical Research Center IRB, and the Office for Human Research Protection (OHRP)). We will use an identification number rather than participants' names on study records. The information participants provide will be stored on secured network drives and will not be identified using any personal information.

Participants' names and other facts that might identify them will not appear when we present this study or publish its results. The findings will be summarized and reported in group form. Participants will not be identified personally. All participants will have ample opportunity during consent and throughout the study to ask questions concerning study procedures. These questions will be answered promptly and fully by study staff to ensure participant ease. A participant may choose not to answer questions or participate in study procedures at any time.

Data Safety Monitoring Plan

Study recruitment, study progress, participant complaints, data collection, data management, data integrity, data security, and eventually data analysis will be staffed at weekly meetings at PBRC. Also, Dr. Roe and his team will be briefed on the progress of data collection at regularly scheduled teleconference, which will occur approximately once every month or every other month.

Compensation for Research-Related Injury

No form of compensation for medical treatment or for other damages (i.e., lost wages, time lost from work, etc.) is available from the Pennington Biomedical Research Center. In the event of injury or medical illness resulting from the research the participant will be referred to a treatment

facility. Medical treatment may be provided at their expense or at the expense of their health care insurer (e.g., Medicare, Medicaid, Blue Cross-Blue Shield, Dental Insurer, etc.) which may or may not provide coverage. PBRC is a research facility and provides medical treatment only as part of research protocols. Should the participant require ongoing medical treatments, they must be provided by community physicians and hospitals.

Economic Burden to Subjects

There will be no study related costs to the participant with the exception of traveling to the PBRC for the study visits. However, use of the FoodImage app will use data from the participant's cellular data plan. Hence, it is possible that the participant would incur cost for this data and this is clearly disclosed in the consent form.

Consent Process

All subjects participating in the study will provide written informed consent. The consenting process will take place in private rooms at Pennington Biomedical Research Center and will be conducted according to Pennington Biomedical consenting guidelines and practices. Participants can take the consent form home to review prior to deciding if they wish to enroll. All participants are free to withdraw from the study at any time.

References

1. InnovationSeeds, *South Korea's food waste reduction policies*, A.f. <http://www.innovationseeds.eu/Policy-Library/Core-Articles/South-KoreaS-Food-Waste-Reduction-Policies.kl>, Editor. 2016.
2. Okawa, K., *Market and Trade Impacts of Food Loss and Waste Reduction*. OECD Publishing.
3. Parfitt, J., M. Barthel, and S. Macnaughton, *Food waste within food supply chains: quantification and potential for change to 2050*. Philosophical Transactions of the Royal Society B: Biological Sciences, 2010. **365**(1554): p. 3065-3081.
4. Quested, T., R. Ingle, and A. Parry, *Household Food and Drink Waste in the United Kingdom 2012*, in WRAP. 2013: London.
5. Secondi, L., L. Principato, and T. Laureti, *Household food waste behaviour in EU-27 countries: A multilevel analysis*. Food Policy, 2015. **56**: p. 25-40.
6. Quested, T. and P. Luzecka, *Household food and drink waste: A people focus*, WRAP, Editor. 2014.
7. Gustavsson, J., et al., *Food losses and food waste: extent, causes and prevention*, FAO, Editor. 2011: Rome.
8. FAO, *Food wastage footprint-Impacts on natural resources: summary report*., F.a.A.O.o.t.U. Nations, Editor. 2013.
9. Bagherzadeh, M., M. Inamura and H. Jeong, *Food Waste Along the Food Chain*. OECD Publishing.
10. Buzby, J.C., H.F. Wells, and J. Huymann, *The Estimated Amount, Value, and Calories of Postharvest Food Losses at the Retail and Consumer Levels in the United States*, EIB-121. USDA-ERS Economic Information Bulletin, 2014. **121**.
11. EPA, U.S., *Advancing sustainable materials management: 2013 Fact Sheet United States* E.P. Agency, Editor. 2015.
12. Godfray, H.C.J., et al., *Food Security: The Challenge of Feeding 9 Billion People*. Science, 2010. **327**(5967): p. 812-818.
13. Grizzetti, B., et al., *The contribution of food waste to global and European nitrogen pollution*. Environmental Science and Policy, 2013. **33**: p. 186-195.
14. Tilman, D., et al., *Global food demand and the sustainable intensification of agriculture*. Proceedings of the National Academy of Sciences, 2011. **108**(50): p. 20260-20264.
15. ReFED, *Rethinking Food Waste through Economics and Data: A roadmap to reduce U.S food waste by 20 percent*. 2016: Boston, MA.
16. Porpino, G., *Household Food Waste Behavior: Avenues for Future Research*. Journal of the Association for Consumer Research, 2016. **1**(1): p. 41-51.
17. Wansink, B. and K. van Ittersum, *Portion size me: plate-size induced consumption norms and win-win solutions for reducing food intake and waste*. J Exp Psychol Appl, 2013. **19**(4): p. 320-32.
18. Just, D.R. and B. Wansink, *The Flat-Rate Pricing Paradox: Conflicting Effects of "All-You-Can-Eat" Buffet Pricing*. Review of Economics and Statistics, 2010. **93**(1): p. 193-200.
19. Martin, C.K., et al., *Validity of the Remote Food Photography Method (RFPM) for estimating energy and nutrient intake in near real-time*. Obesity, 2012. **20**(4): p. 891-899.

20. Martin, C.K., et al., *A novel method to remotely measure food intake of free-living individuals in real time: the remote food photography method*. The British journal of nutrition, 2009. **101**(3): p. 446-56.
21. Greevy, R., et al., *Optimal multivariate matching before randomization* Biostatistics, 2004. **5**(2): p. 263-275.
22. Bruhn, M. and D. McKenzie, *In Pursuit of Balance: Randomization in Practice in Development Field Experiments*. American Economic Journal: Applied Economics, 2009. **1**(4): p. 200-232.