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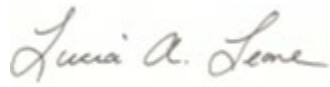
Statistical Analysis Plan (SAP)

Adapting the Veggie Van Mobile Market Intervention to Address Disparities in Nutrition
Security Among College Students

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SIGNATURE PAGE

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Lucia Leone

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Angelica Tutasi-Lozada

ABBREVIATIONS

BRFSS	Behavioral Risk Factor Surveillance System
UB	University at Buffalo
DSQ	Dietary Screener Questionnaire (National Cancer Institute)
FV	Fruits and Vegetables
GLMM	Generalized Linear Mixed Model
IRB	Institutional Review Board
MM	Mobile Market
SAP	Statistical Analysis Plan
SNAP	Supplemental Nutrition Assistance Program
USDA	U.S. Department of Agriculture
VV	Veggie Van

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1. Introduction

The University at Buffalo (UB) Campus Veggie Van (Campus VV) is a campus-based implementation of the Veggie Van mobile produce market model. The 2024-2025 Campus VV pilot was designed to increase access to affordable, high-quality fruits and vegetables and to support nutrition security among students who experienced food security the past academic year. The pilot operated across the Fall 2024 and Spring 2025 semesters (approximately 26 weeks). This statistical analysis plan (SAP) specifies the study endpoints and the analytical approaches that will be used to evaluate changes in outcomes from baseline to follow-up and to explore whether changes differ by intervention engagement (market usage).

2. Study design

The 2024-2025 Campus VV pilot employed a single-arm pretest-posttest design in which participants served as their own controls. Eligible UB students (≥ 18 years) with food insecurity (USDA 10-item Adult Food Security Module score ≥ 3) were recruited in August–September 2024. Baseline data were collected in early Fall 2024, and follow-up data were collected in late April 2025, immediately after the pilot's conclusion. Outcomes were assessed via online surveys at both time points, and dermal carotenoids were measured in person using the Veggie Meter®. Participant market engagement was captured objectively through point-of-sale (Farmers' Register©) records linked to participants' registered phone numbers.

This study is a pilot evaluation; therefore, formal power calculations were not used to determine sample size. A total of 130 students enrolled, 125 completed baseline and comprised the analytic cohort. Precision of estimates and feasibility metrics (recruitment, engagement, retention, and completeness of outcome measures) are primary considerations for interpreting findings.

3. Aims and objectives

Aim 1: To assess changes in fruit and vegetable intake, food security, and nutrition security from baseline (Fall 2024) to follow-up (Spring 2025) among Campus VV participants.

Aim 2: To examine whether changes in outcomes differ by intervention engagement, operationalized as frequent use (≥ 8 market visits over the academic year) versus rare/non-use (0–7 visits).

Aim 3: To assess changes in perceived healthfulness of choice and dietary choice from baseline to follow-up, and to explore whether changes differ by engagement..

4. Outcomes

This section defines the primary and secondary outcomes, including measurement timing and scoring.

4.1 Primary Outcome

Self-reported consumption frequency of FV

Assessed using the NCI Dietary Screener Questionnaire (DSQ) fruit and vegetable module at baseline and follow-up. Responses will be summarized as total frequency of fruit and vegetable consumption (times/day), with higher values indicating more frequent intake.

Dermal carotenoids (Veggie Meter® score)

Measured at baseline and follow-up as the average of three finger scans. Higher scores indicate higher dermal carotenoid levels, an objective biomarker of carotenoid-rich produce intake.

4.2 Secondary Outcomes

Food security score (USDA 10-item Adult Food Security Module; 0-10)

Higher scores indicate greater food insecurity. Analyses will focus on change in raw score; categorical food security classification will be described descriptively.

Nutrition security score (Center for Nutrition and Health Impact 4-item Household Nutrition Security scale; 0–4)

Items will be averaged after appropriate scoring such that higher scores indicate greater nutrition security.

4.3 Other Outcomes

Healthfulness of choice (Center for Nutrition and Health Impact 3-item scale; 0-4)

Average score; higher values indicate greater perceived ability to access foods that meet health needs.

Dietary choice (Center for Nutrition and Health Impact 3-item scale; 0-4)

Average score after reverse scoring as needed; higher values indicate greater dietary autonomy

5. Population to be Analyzed

The primary analytic population will include all enrolled participants who completed both baseline and follow-up assessments for the outcomes of interest regardless of level of Campus VV use. For outcomes requiring in-person assessment (Veggie Meter®), analyses will include participants with non-missing measurements at both time points. Engagement subgroup analyses will be conducted among participants with valid point-of-sale usage data.

6. Analyses

All tests will be two-tailed with $\alpha=0.05$. Estimates will be presented with 95% confidence intervals where feasible. Analyses will be conducted using SAS 9.4. Continuous outcomes will be summarized using mean (SD) and/or median (IQR) as appropriate; categorical variables using counts and percentages.

Participant characteristics and baseline outcome distributions will be summarized for the full cohort and by engagement group (frequent vs rare/non-use). Baseline differences between engagement groups will be explored to inform covariate adjustment in multivariable models.

For within-participant changes from baseline to follow-up, paired statistical tests will be used:

- Continuous outcomes: paired t-tests (or Wilcoxon signed-rank tests if distributions are markedly non-normal).
- Binary outcomes: McNemar's test.
- Multi-category outcomes: Bowker's test of symmetry.

These analyses will be performed for each defined outcome.

To evaluate whether outcome changes differ by engagement level, analyses will proceed in two steps:

- 1) Stratified pre-post analyses will be conducted separately among frequent users and rare/non-users.
- 2) For each continuous outcome, a linear mixed-effects model will be fit with time (baseline vs follow-up) as a repeated measure and an interaction term between time and engagement group (time×engagement). A statistically significant interaction ($p < 0.05$) will be interpreted as evidence that the magnitude of change differs by engagement.

Models will include a participant-level random intercept to account for within-person correlation. Covariates will be selected a priori based on the first pilot and on observed baseline to follow-up differences between engagement groups; candidate covariates include academic level (undergraduate vs graduate), first-generation status, employment, housing, car ownership, Pell grant eligibility, first generation, and demographic characteristics.

An exploratory comparison will be conducted between participants who never used the market (0 visits) and those who used the market at least once (≥ 1 visit) to evaluate whether simply being enrolled (with access to incentives and educational materials) is associated with measurable change among non-users. These analyses are considered hypothesis-generating.

Given the pilot design, primary analyses will use complete-case data for each outcome. Patterns of missingness will be described (e.g., follow-up nonresponse, missing Veggie Meter measures). As a sensitivity analysis for continuous outcomes, mixed-effects models inherently accommodate participants with partially observed repeated measures under a missing-at-random assumption when maximum likelihood estimation is used.

Because multiple outcomes are evaluated, findings will be interpreted with attention to consistency of effects across related measures (e.g., self-reported and objective FV intake) and the exploratory nature of secondary and subgroup analyses. Formal multiplicity adjustments will not be applied; effect sizes will be emphasized alongside p-values.

Data sources include baseline and follow-up surveys, institutional records for selected demographics, point-of-sale usage logs, and Veggie Meter® readings. Data will be merged using unique study identifiers. Range checks and logic checks will be conducted prior to analysis;

scoring algorithms for multi-item scales will be verified by double programming and/or independent review.

Results will be reported as within-cohort baseline-to-follow-up changes, and as engagement-differential changes from mixed-effects models. For continuous outcomes, change estimates will be presented as mean differences (follow-up minus baseline) with 95% CIs; for models, estimated marginal means by time and engagement and the interaction term will be reported.

Additional analyses by question set can be found below:

Question Set	Answer options	Variable Creation	Analysis Plan <i>For all main outcomes we need to control for relevant demographic and contextual variables</i>
Demographics and other contextual variables (13)	Various	Will combine categories with small numbers of respondents	<ol style="list-style-type: none"> 1. Descriptive 2. Will test for pre-post changes using paired statistical tests.
FV	Frequency (times per day)	Continuous	<p>Aim 1 Outcome. We hypothesize an increase in FV consumption between baseline and follow-up</p> <p>Aim 2 Outcome. We hypothesize a higher increase in FV consumption among frequent participants (≥ 8 market visits over the academic year) versus rare/non-users (0–7 visits).</p>
Dermal carotenoids	Veggie Meter® score	Continuous	<p>Aim 1 Outcome. We hypothesize an increase in dermal carotenoids scores between baseline and follow-up</p> <p>Aim 2 Outcome. We hypothesize a higher increase in dermal carotenoids scores among frequent participants (≥ 8 market visits over the academic year) versus rare/non-users (0–7 visits).</p>

Food security score	USDA 10-item Adult Food Security Module; 0–10	Continuous	<p>Aim 1 Outcome. We hypothesize a decrease in food security scores between baseline and follow-up</p> <p>Aim 2 Outcome. We hypothesize a higher decrease in food security scores among frequent participants (≥ 8 market visits over the academic year) versus rare/non-users (0–7 visits).</p>
Nutrition security score	4-item Household Nutrition Security scale; 0–4	Continuous	<p>Aim 1 Outcome. We hypothesize an increase in nutrition security scores between baseline and follow-up</p> <p>Aim 2 Outcome. We hypothesize a higher increase in nutrition security scores among frequent participants (≥ 8 market visits over the academic year) versus rare/non-users (0–7 visits).</p>
Healthfulness choice	3-item scale; 0–4	Continuous	<p>Aim 3 Outcome. We hypothesize an increase in healthfulness choice scores between baseline and follow-up, and a higher increase in scores among frequent participants (≥ 8 market visits over the academic year) versus rare/non-users (0–7 visits).</p>
Dietary choice	3-item scale; 0–4	Continuous	<p>Aim 3 Outcome. We hypothesize an increase in dietary choice scores between baseline and follow-up, and a higher increase in scores among frequent participants (≥ 8 market visits over the academic year) versus rare/non-users (0–7 visits).</p>