

MEASURING FOOD INSECURITY AMONG COLLEGE STUDENTS

BY

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DISSERTATION

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ABSTRACT

Background. Mounting evidence suggests that college (i.e., postsecondary) students are at a greater risk of experiencing food insecurity (FI) – the lack of sufficient access to adequate food for a healthy and active life – than the general U.S. population. However, there is a paucity of psychometric evaluations of common FI assessment surveys for this population.

Objective. To understand if current FI surveying methods are appropriately capturing and classifying U.S. undergraduate college students.

Methods. The existing literature was systematically reviewed and 51 study samples were analyzed using meta-analysis techniques. Specifically, an overall weighted estimate of college FI was produced and the impact of study characteristics (e.g., sampling strategy, survey type, and reference period) on FI estimates were investigated. In addition, an online survey was sent to a randomized sample of 4,000 undergraduate students to characterize response patterns on FI questionnaire items. Psychometric analyses were conducted on the 462 student responses to compare varying survey protocols and evaluate item response statistics. Among students who responded to the online survey and agreed to be contacted for future studies, a random subset was invited to participate in the in-person phase. An exploratory analysis was conducted with students (n=66) who participated in the in-person phase and provided responses on FI questions using paper-and-pencil surveys. This repeated-measures study sample was used to test the impact of survey modality (online or paper-and-pencil) on FI responses, and resulting FI prevalence rates. A subset of this sample (n=33) students participated in in-person qualitative cognitive interviews to understand how they interpreted questionnaire items and how students responded to

experiences of FI. The transcripts of these interviews were analyzed using a basic interpretative approach.

Results. The meta-analyses indicated that an estimated 38% (95% CI: 33%, 43%, I2: 99.7%) of U.S. college students experience FI. However, the type of survey and the reference period used in surveys were significantly related to the resulting FI rate, producing estimates ranging from 17% to 46% across the study sub-groups. Psychometric analyses of the online survey revealed students' response patterns on FI questions deviated from expectations. Item infit and outfit statistics reflected poor discrimination for many of the questions. Each surveying protocol tested had low model fit, but the 10-item Food Security Survey Module (FSSM) paired with a 2-item screener had the best fit (McFadden's $R^2=0.15$ and Bayesian Information Criterion=-2049.72) compared to shorter surveys or those that did not include a screener. When students answered items on the 10-item FSSM and the 2-item screener, they were less likely to affirm each item on a paper-and-pencil survey, when compared with the online modality. Therefore, paper-and-pencil surveys produced a 25.8% FI prevalence compared to 40.9% FI estimated from the online survey. The cognitive interviews provided rich data that may explain the psychometric issues with the questionnaire items. Specifically, students had unique interpretations of key terms – such as “money for more” and “balanced meals” – used in FI surveys.

Conclusion. Overall, this body of work illustrates several shortcomings of current FI surveying methods used with college students. Further psychometric tests on modified FSSMs, or new FI surveys, will be needed for this population to ensure students are not misclassified and that students experiencing FI are best supported.

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LIST OF ABBREVIATIONS

CPS	Current Population Survey
FI	food insecurity
FSSM	Food Security Survey Module
IRB	Institutional Review Board
USDA	United States Department of Agriculture

CHAPTER 1: INTRODUCTON

Food security is defined as access by all people, at all times, to enough food for an active, healthy life (Coleman-Jensen, Rabbitt, Gregory & Singh, 2018). Individuals, and households, experiencing food insecurity (FI) have a shortcoming in one, or more, of the dimensions of food security. An estimated 11.8% of U.S. households experienced FI in 2017 (Coleman-Jensen et al., 2018). These households are at greater risk of a number of negative health outcomes, when compared to food secure households (Gundersen and Ziliak, 2015). In identifying households experiencing FI, researchers have identified regional, economic, and demographic predictors (Gundersen & Ziliak, 2018).

A growing body of literature has indicated that college (i.e., post-secondary) students are at an elevated risk of experiencing FI. Rates of FI are three- to four-fold greater than the general population, with estimates ranging from 32.9 to 50.9% in recent literature reviews (Bruening, Argo, Payne-Sturges & Laska, 2017; Nazmi et al., 2018). College students who experience FI also report compromised dietary patterns, health, and psychosocial experiences (Bruening et al., 2017; Meza, Altman, Martinez & Leung, 2018; Bruening, van Woerden, Todd & Laska, 2018). These findings have provoked national investigations into college FI, resulting in recent policy recommendations by the Government Accountability Office (GAO, 2018).

The majority of literature on college FI uses the U.S. Department of Agriculture's (USDA) Food Security Survey Modules (FSSM), which have a strong legacy of evidence for their development and use in the general population (Campbell, 1991; Radimer, Olson, Greene, Campbell & Habicht, 1992; Wehler, Scott & Anderson, 1992; Blumberg, Bialostosky, Hamilton & Briefel, 1999; Carlson, Andrews & Bickel, 1999; Frongillo Jr, 1999). However, there has been

a paucity of psychometric evaluations of these surveys with the college student population. It is unclear if the FSSMs are appropriate measures of FI among students. The following research was conducted to address this gap in the literature.

Several studies, using both quantitative and qualitative techniques, were undertaken to understand potential psychometric issues with current surveying methods. Chapter two describes a meta-analysis of college FI literature from 1995 to 2018. The impacts of surveying methods are tested with meta-regressions to understand their impact on resulting FI prevalence rates. Next, chapter three provides results of data collected from undergraduate students on an online survey. Student data are used to describe response patterns, evaluate item fit statistics, and compare four FI surveying protocols. Chapter four focuses on an exploratory investigation comparing FI response patterns, and the resulting FI prevalence estimates, produced from two surveying modalities (online versus paper-and-pencil). Finally, chapter five describes qualitative responses and interpretations of college students on FSSM questions. These cognitive interviews illustrate underlying issues that may threaten the content validity of the questionnaire.

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CHAPTER 2: FOOD INSECURITY AMONG COLLEGE STUDENTS IN THE U.S.: A SYSTEMATIC REVIEW AND META-ANALYSIS¹

Abstract

Reports of college students experiencing food insecurity, defined as inadequate access, availability, adequacy, and stability of food, have sparked national calls for alleviation and prevention policies. However, there are a wide variety of food insecurity (FI) rates reported across studies and even among recent literature reviews. The current systematic review aimed to develop a weighted estimated prevalence of FI among U.S. students using a comprehensive search approach. In addition, meta-analyses were used to identify study characteristics that may explain the high FI prevalence variability. To address these objectives, the peer-reviewed and grey literature on U.S. college student FI were systematically searched to identify 12,044 non-duplicated records. A total of 51 study samples, across 62 records, met inclusion criteria and were used in the current analysis. FI estimates ranged from 10% to 75%, with the overall prevalence estimated to be 38% (95% CI: 33%, 43%, I²: 99.7%). The survey methods used were significantly related to the produced FI estimates. The U.S. Department of Agriculture (USDA) Short Form Food Security Survey Module (FSSM; 46%; 95% CI: 41%, 52%; P<0.001) and the USDA Adult FSSM (37%; 95% CI: 33%, 42%; P=0.017) prevalence estimates were larger when compared with the full USDA Household FSSM (17%; 95% CI: 12%, 22%). When these surveys referenced a 12-month period, FI estimates were 37% (95% CI: 30%, 43%). This was significantly lower than surveys using reference periods of nine months or shorter (46%; 95% CI: 41%, 51%; P=0.039). No other tested study or sample characteristics were significantly

¹ Currently under review for publication in *Advances in Nutrition: An International Review Journal*

related to FI estimates. The results indicate that FI is a pressing issue among college students, but the variation in prevalence produced by differing surveys suggests that students may be misclassified with current surveying methods. Psychometric testing of these surveys when used with college students is an essential next step.

Introduction

Food insecurity (FI) is the limited or uncertain access to sufficient nutritious food. An estimated 11.8% of American households experienced FI during 2017 (1). Adults experiencing FI are more likely to have low quality dietary patterns (2-4). Ultimately, experiences of FI are associated with diminished mental and physical health (5-10). Allowing FI to persist in the U.S. compromises the quality of life and widens health disparities for millions of Americans.

A recent growing concern is the high reported prevalence of FI among post-secondary students (11), with some studies reporting more than half of students are FI. Numerous peer-reviewed articles, online reports, and news pieces have elicited concern for U.S. college students facing hunger. These reports have been met with calls to address these issues with policies and programs, such as campus food pantries or financial aid modifications (12). As U.S. colleges and universities begin to enroll a diversity of students with varying socio-cultural backgrounds, changes to better support the types of students, and their respective concerns, become essential.

Though the high FI prevalence rates are used as evidence that policy interventions are needed, the ability to take well-informed actions is hindered by the limited larger synthesis and analysis of the growing body of literature. There have been three recent reviews, each limited in scope or practical applications for the field. A seminal review by Bruening et al. (13) provided a narrative review of studies and produced the estimated prevalence of FI affecting one-third of

college students, which is commonly referred to in the popular press. However, this estimate was unweighted across studies, thus not considering the size of each study, and the inclusion of studies from outside of the U.S. limited the specificity. A second review from Nazmi et al. (14) provided a review of U.S. studies. Nazmi and colleagues (14) calculated a weighted prevalence estimate much higher than produced in the original review, with an estimated 47.2% to 50.9% of students experiencing FI. Though, Nazmi et al. (14) provided a weighted U.S. specific estimate, it was lacking in two critical areas. First, fewer studies were included in this later review than were U.S.-based and originally identified in Bruening et al. (13). This was counterintuitive, given the later date of the work, and indicated that many studies may have been overlooked. Secondly, Nazmi et al. (14) provided analyses of the included studies and how prevalence varied by region or methodology but results were largely descriptive leaving limited actionable implications. Finally, the Government Accountability Office recently published a governmental narrative literature review (12). This report was the most recent review in this area and advanced the field by evaluating food insecurity alleviation efforts. However, the analysis of FI was, again, narrative and, given the intended non-specialist audience, the methodology was unclear. Though these reviews presented descriptive overviews of the field, their shortcomings warranted a new meta-analytical approach to evaluate the prevalence of FI among U.S. college students.

The aims of the current review focus on producing a weighted estimated prevalence of FI among U.S. students and analyzing how study characteristics relate to this estimate. The two primary questions for the current systematic review are: 1) what is the prevalence of FI among students at community colleges and four-year universities in the U.S.? And, 2) what study characteristics impact FI prevalence estimates?

Methods

All procedures for the systematic review were conducted based on the *Cochrane Handbook for Systematic Reviews of Interventions* (15) and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (16). The protocol for the review was registered on July 10, 2017 and publicly available on the PROSPERO register, under number CRD42017069902 (17).

Four databases were used for the initial identification of articles: 1) PubMed/Medline; 2) EBSCO Host, Academic Search Complete; 3) Web of Science, and 4) ProQuest. In each database, every combination of the following keywords were used: (Food insecur* OR Food secur* OR Food insufficien* OR Hunger OR Food access) and (University student* OR College student*). To identify ‘grey literature’ (non-peer-reviewed reports of studies), theses/dissertations were included in the ProQuest database, authors of relevant studies were asked for additional unpublished results or suggested citations, and websites of organizations/associations conducting work related to FI in college students were searched for reports and recommended publications (Wisconsin HOPE Lab, College and University Food Bank Alliance, Feeding America, National Student Campaign Against Hunger and Homelessness). To extend the comprehensiveness of searches, citations selected for full-text review were also used for a reference list search (backward reference search) and cited reference search (forward reference search). All database searches, reference searches, and author communications were conducted and logged between June 2017 and June 2018.

Study Eligibility Criteria. Title and abstract results from the systematic searches were independently screened by two researchers. To be eligible for inclusion, studies must have: 1) collected data and/or been published after 1995 (when FI terminology became consistent in the

U.S.); 2) been written in English; 3) reported quantitative categorical outcomes of U.S. university students related to FI; 4) indicated the method for evaluating FI, and 5) provided no intervention or provided baseline characteristics prior to an intervention. This initial screen resulted in exclusion or consideration for further full-text review. The full texts of all citations considered for further review were, again, screened independently by two researchers based on the criteria outlined above. For the articles that did not indicate the year in which data were collected, these data were assumed to be collected after 1995, if the article were published after the year 2000.

The records from each citation were reviewed and organized to represent individual study samples. Sixty-two records reported on studies that met eligibility criteria (Figure 2.1). When publications reported on multiple studies or reported unique results (including sociodemographic characteristics and FI estimates) for 2-year and 4-year students, the records were split to represent their distinct samples. One publication included data from four studies (18) and one report presented results for 2-year and 4-year student samples separately (19), bringing the total up to 66 studies. Following this, when separate records reported on the same study, the record published later was included in the final analyses. If details were given in the initial record but omitted in the later record, those were used to supplement the study details and subsequent description. Fifteen records were identified as earlier or preliminary publications—e.g., presentation abstracts, and grey reports—that had later publications identified in the search (20-34). These records were used to provide supplemental information to describe study characteristics, with details reported in later publications (18, 35-42) used for analyses. After accounting for the overlap in those records, a total of 51 distinct samples were identified.

Data Extraction. Data were extracted from each study by the lead author and independently checked for accuracy by one other researcher. Discrepancies were reconciled by the lead and last authors. Using a standardized form, extracted characteristics included authors, publication year, grey literature or peer-reviewed source, year/month of data collection, study design, study population, sampling and recruitment strategies, sample size, sample demographics, size and location of university, FI measurement tool, FI reference period, medium (e.g., online, and in-person) of FI assessment, prevalence of FI, relationship of correlates to FI, and statistical methods. Unless otherwise stated, students who participated in each study were assumed to be enrolled at the reported institution granting human subjects research review. When more than one article reported on the same set of data, information was extracted from all reports to provide a comprehensive picture of the study; when details were inconsistent, the report published later was assumed to be the most up to date analysis and superseded earlier reports.

Quality Assessment. The quality of each study described in a full article, report or book was evaluated on five criteria based on a scale used previously (43) that is grounded in the *Methods Guide for Effectiveness and Comparative Effectiveness Review* (44). The five criteria used to assess the quality were: 1) an *a priori* aim/hypothesis; 2) a specific study population; 3) rigorous participant recruitment; 4) sufficient sample size, and 5) reliable and valid measures of FI. Each criterion was evaluated on a scale of zero to two, where unmet/unmentioned responses = 0, partially met responses = 1, and completely met responses = 2; the criteria and scoring are presented in Table 2.1. For the aim/hypothesis, an explicit mention of FI was assigned a 2, implication of FI was assigned a 1, and no mention of an aim/hypothesis was assigned a 0. For the population criteria, a population was considered clearly defined (score of 2) if inclusion/exclusion criteria for participation or the sampling frame were provided, partial/broad

if limited criteria were presented (score of 1), and unmet if no criteria or population expectations were provided (score of 0). The recruitment criterion was assessed by scoring convenience sampling techniques as 0, there was no category assigned a score of 1, and simple or stratified random sampling techniques were scored as 2. For sample size, samples of >1000 were scored a 2, samples of 100–999 students were scored a 1, and samples with <100 students were scored a 0. Reliability and validity of FI assessments were scored as 2 when the survey had psychometric testing in a related population, scored as 1 when the survey had limited testing or testing in a different population, and scored as 0 when the survey had no psychometric testing reported. When all five criteria were evaluated, a total score ranging from 0–10 was obtained. When more than one article reported on the same set of data, the quality criteria information provided in both reports was aggregated to determine the quality rating. This quality assessment process was conducted by two independent researchers, with discrepancies discussed prior to formalizing the score. The quality of included abstracts, if not followed by a lengthier report, was not evaluated due to insufficient information to score each criterion. Quality assessments for each included study were evaluated descriptively (mean and standard deviation) to provide an estimate for the overall strength of the evidence reviewed.

Quantitative Synthesis. Study and sample characteristics were descriptively analyzed with percentages and medians (given skewedness of data). Prevalence of FI among university students was estimated using a meta-analysis random effects model and presented as a forest plot. The classification of low and very low security was descriptively analyzed for common patterns. Additional meta-analyses/regressions were conducted on FI and study characteristics, when reported by sufficient studies. Study heterogeneity was assessed using the I^2 index. Publication bias was assessed with Begg's and Egger's tests. All statistical analyses were

conducted using Stata/MP 14.1 (StataCorp, College Station, TX, USA). Statistical significance was set to $P < 0.05$.

Results

Basic characteristics of the included studies are outlined in Table 2.2. Though the review included reports published after 1995, most records were published in 2016 or later. Over half of the studies were published as peer-reviewed articles, but a considerable second group of studies were reported through grey literature as online reports and academic theses or dissertations. The majority (96.1%) of studies included in this review were cross-sectional, with only two records reporting results of longitudinal designs. Sample sizes ranged from 49 to 26,131 participants with a median of 514 per study. Of the studies that reported their sampling strategy, convenience sampling (44.7%, $n=21$) and census approaches (29.8%, $n=14$) were most common. Response rates ranged from $<1\%$ to 99% with a median of 13.7% for the 38 studies that provided rates.

Most studies listed no or minimal eligibility criteria (i.e., enrolled student over 18 years old) for study participation, with only 18 studies (35.3%) listing more restrictive criteria. Given minimal eligibility criteria, it was common for studies to report including both graduate and undergraduate students (43.8%, $n=21$). Though one study included only male collegiate athletes, it was more common for studies to include a higher proportion of female students, with a median of 70% among 43 studies. Studies commonly captured what would be considered the traditionally aged college student (18-24 years old), though studies varied in reporting the average age or the percent within this category. Among 21 studies reporting averages, the median age was 21.7 years old, and among those reporting the percent the median was 72% of students were 18-24 years old. Though the percent of white students ranged from 0% to 92%

among the n=40 studies that reported race/ethnicity, the median was 55% white students. Few studies reported employment (n=19) and financial aid (n=17) characteristics, but among these studies a median of 61.3% of students were employed while enrolled in school and a median of 67% of students received financial aid (however, classifications of aid varied across studies). International student status was reported in 11 studies and the median was 9% international students.

The majority of studies (75%, n=36) were single site (i.e., one institution) studies, but eight studies surveyed FI across ≥ 10 institutions. Conducting surveys with students at 4-year universities only was the most common (80%, n=41), but seven studies reported on solely community college students (i.e., 2- to 4-year institutions) (14%). An additional three (6%) studies reported on samples that included both university and community college students.

Table 2.3 details the FI assessment protocols of the included studies. The majority of studies (80.4%, n=41) reported the use of USDA Food Security Survey Modules (FSSMs) to assess FI. The 6-item Short FSSM and the 10-item Adult FSSM together accounted for 64.7% of protocols. However, there was a subset of four studies (7.8%) which reported use of USDA FSSMs, without specifying the survey form used. Though the minority, another 10 studies used novel FI assessment protocols without standard security categorizations to compare with prior FI research. Among the 44 studies that reported the FI reference period, the majority (63.6%) asked students to refer to the last 12 months. Another five studies used novel reference periods of three, four, and nine months. Forty-eight studies reported survey distribution procedures with some using multiple distribution methods (n=5). Online platforms (n=40) and in-person distribution (n=7) were more popular than phone (n=3) or mail (n=2) methods.

Quality assessments of each study are presented in Table 2.4. The average overall score for each study was 6.9 (\pm 1.5), on a scale of 0 to 10. Studies ranged in quality ratings from 5 to 9. Most studies completely met the *a priori* hypothesis criteria, with only one study receiving a score of one. The lowest average criteria, of 1.0 (\pm 0.3) across studies, was the reliable/valid FI survey criteria due to the common use of surveys with minimal testing or no testing with the college population.

FI prevalence estimates ranged from 10% to 75% in all studies. The overall estimate using a random effects meta-analysis, shown in Figure 2.2, was 38% (95% CI: 33%, 43%). The measure of study heterogeneity, the I^2 , from this analysis was 99.7%. Thirty-seven studies further classified these students with FI as having low or very low food security. Figure 2.3 presents these estimates, showing that it was common for very low security to be as or more prevalent than low food security. There was no evidence of publication bias from the Begg's test with continuity correction ($P=0.63$) and the Egger's test ($P=0.96$). Subgroup analyses using random effects meta-regression were performed with various study characteristics, and estimates of the sub-groups are shown in Table 2.5. The FI survey used was related to the prevalence estimate, with the USDA Short Form FSSM (46%; 95% CI: 41%, 52%; $P<0.001$) and the USDA Adult FSSM (37%; 95% CI: 33%, 42%; $P=0.017$) producing significantly larger estimates when compared to the full USDA Household FSSM (17%; 95% CI: 12%, 22%). The reference period used on these surveys was also significantly related ($P=0.04$) to the prevalence estimate, with a lower prevalence of 37% (95% CI: 30%, 43%) produced with a 12-month reference when compared to reference periods of nine months and shorter (46%; 95% CI: 41%, 51%). Sampling strategy, student class composition, institution type, and number of institutions surveyed were not significantly related to prevalence estimates ($P>0.05$). There was also no significant

relationship between sample characteristics (i.e., sex, age, and race) and prevalence estimates when tested with random effects meta-regression (data not shown).

Discussion

The aim of this review was to develop a weighted estimate of FI among U.S. college students and use meta-analytical techniques to test if study characteristics were related to prevalence estimates. An estimated 38% of U.S. college students reported experiences of FI. However, this prevalence was influenced by the assessment protocols, including the survey form and reference period. To the authors' knowledge, the current review serves as the most comprehensive systematic review of the literature and is the first to take a meta-analytical approach. This approach has revealed several insights from the literature: 1) the body of work is distinct from the general FI literature; 2) psychometric testing of the USDA FSSMs is warranted; 3) reference periods used in FI surveys are important; 4) the impact of institution is unknown, and 5) measurement accuracy is essential to understanding predictors and consequences among students experiencing FI.

The composition and quality of the literature studying FI among college students is distinct from the general FI literature. First, there is a large proportion of grey literature (i.e., online reports and academic theses) and conference abstracts. These variations in publication channels may explain the variation in number of studies included in prior reviews (13, 14). The quantity and rigor of peer review is also variable in grey publications. The area of college FI research is rapidly growing in size. The first record in this review was published in 1999, but it was the only college FI research for almost 10 years until 2009. Since then, work in this area has grown at an exponential pace resulting in over 30 records published in 2016 or later. Studies

were commonly cross-sectional, limited to students from a single institution, used minimal eligibility criteria, and frequently focused on the 18-24 year old student population. The quality of studies was moderate, with an average rating of 7 on a scale of 0 to 10. These characteristics allow for this review to capture a broad characterization of FI prevalence among “traditional” university students, but the ability to talk about specific sub-populations is hindered. Further, there are concerns about interpreting the overall estimate of FI prevalence produced from this meta-analysis and generalizing this as the population prevalence given the variability in study scope and the significant impact of FI assessment protocols.

Both the FI survey type and reference period used within the questionnaire were significantly related to prevalence estimates. Unlike what was expected, and was suggested with the narrative findings in Nazmi et al. (14), the novel surveys with untested methods did not show significant under- or over-estimation when compared with the USDA FSSMs. This may be due to the variety of surveys captured in the other/novel category. To clearly test the FI measurement variation of individual novel surveys, additional psychometric testing would be needed. Surprisingly the greatest variability between FI estimates was produced when comparing USDA FSSMs of different lengths. This is concerning as there is a legacy of strong psychometric evaluation conducted on these surveys that supports their use (82-87) and they have been broadly adopted for various settings across the U.S. and internationally. However, the surveys have limited formal psychometric evaluation among college students. One grey report refers to instrument testing (80), but given the aim of the report to broadly highlight the issues among college students, specific results of these psychometric evaluations were not described. A forthcoming study from Nikolaus et al. (88) describes the psychometric evaluation of the USDA FSSMs among college students and findings are consistent with this review in that the 6-item

USDA FSSM produces the most liberal prevalence estimates. However, the 18-item USDA FSSM, which produced the lowest FI estimate in the current review, was not tested in this recent psychometric study (88). The limited use, and testing, of the 18-item Household FSSM is likely due to its incorporation of eight items specifically querying about children in the household and the low proportion of college students with children.

Prevalence estimates were not only impacted by the survey form used, but also by the reference period used in the survey. The present review found that a lower FI prevalence resulted from surveys using a 12-month reference period. This may be a result of recall bias (i.e., it is harder to remember a year's worth of experiences), but it could also be due to lower rates of FI experiences among students when not enrolled in school. McArthur et al. (81) evaluated FI among freshman both prior to and during their enrollment, and found higher FI rates after enrollment when compared to before enrollment. The inclusion of months where the student is not enrolled, and possibly living with family may, in part, explain the lower rates produced when using a 12-month reference period. It is possible that the relationships between FI prevalence and surveying protocols (both survey form and reference period) may be due to study characteristics, such as institution type. However, the distribution of surveying methods was fairly mixed across institution type and other study characteristics of interest in the current meta-analysis. Therefore, it is clear that future psychometric evaluations of these protocols are warranted to ensure that FI prevalence estimates are accurate and policy efforts can be assessed with fidelity.

As evidenced by the high I^2 index, it is clear that there is high heterogeneity across studies. This high heterogeneity across studies may, in part, be explained by the inherent heterogeneity of education institutions. It was originally hypothesized that institution type (i.e., community college or university) would be related to FI rates, given the unique characteristics of

these student populations (89, 90). Unexpectedly, the meta-regression did not support any relationship between FI prevalence and institution type. However, these non-significant results may be due to the contribution of other sources of variation and error. It was not common for estimates of FI to be separately reported for community college and university students, limiting the ability to fully understand how these institutions (and their respective student populations) experience FI. In the future, separating estimates of FI for community college and university students is supported by the divergence in FI rates reported in prior work (19). In addition, there are other institution characteristics, beyond this dichotomy, that may be significantly related to FI prevalence among students. Enrollment cost, institution selectivity, student body size, proportion of first-generation students, and academic preparedness may be related to student FI experiences and requires further investigation.

Improvements in FI measurement accuracy among students will be essential to advance the field. Individual-level predictors and consequences of FI among U.S. college students was initially a tertiary research question in the present review, as this is essential information in leveraging resources to best serve students. However, the results indicating variability in FI estimates produced by the different FSSMs elicited concerns about the validity and reliability of these methods for this population. Current surveying methods are potentially misclassifying a proportion of students as secure or insecure, and our understanding of FI experiences among students may not be best captured with our current methods. If individual-level correlates of FI are assessed with inaccurate methodology, relationships will be imprecise leading to under- or over-estimation of effects. Results of observational work are often used to inform policies and alleviation efforts. If these interventions are based on surveys with misclassification biases, they not only run the risk of not reaching their target population but their long-term evaluations of

efficacy may be weakened. Given this, it is imperative to develop new FI surveys or test existing instruments to ensure that experiences among students are best captured. Looking forward, once the FI surveying psychometric evaluations have been made, research evaluating FI risk factors and effects of policies on FI will be essential. One particularly valuable question is the relationship of student income and FI. Many of the included studies attempted to measure student income or financial resources, but methods were inconsistent and it is difficult to ascertain the financial situation of students. This is due to the spectrum of financial independence that is seen in student populations, where familial support may be present but the amount and frequency of support is often difficult to quantify (88).

There are limitations that should be accounted for when interpreting this review. It is possible that some studies evaluating FI among college students may have been missed. The systematic nature of the review supplemented with personal contact among researchers in the field have strengthened the comprehensiveness for inclusion of as many studies published prior to June 2018 as possible. However, this area of research is rapidly growing, as evidenced by the rate of publications in the last three years. It is possible that eligible studies have been published since the synthesis and analysis began in 2018.

This review estimates that 38% of U.S. college students experience FI; this estimate should be interpreted and used with caution. There is wide heterogeneity among studies included in the current analysis, and though the random effects model accounts for this, it is worth considering the differences in student populations at various institutions. Further, the considerable impact of survey methods on the resulting FI estimates in the included studies necessitates future psychometric evaluations. FI is clearly an issue in this population and could have a detrimental impact on students' diet and academic success. Once the surveying methods

have been improved, testing policies and initiatives to alleviate FI, including those already undertaken as well as future developments (12), will be invaluable. Addressing FI among college students is imperative to ensure health, wellbeing and professional success in the next generation.

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Table 2.1. Study quality assessment criteria and coding schema

Criteria	Unmet/unmentioned Response(s) Score = 0	Partially Met Response(s) Score = 1	Completely Met Response(s) Score = 2
A priori aim/hypothesis specific to food insecurity	No mention of aim/hypothesis	Implications of food insecurity in aim/hypothesis (i.e. hunger or difficulty affording food)	Explicit mention of food insecurity in aim/hypothesis
Study population clearly specified and defined	No mention of the population the sample is meant to represent	Population partially and/broadly defined	Population clearly defined
Rigorous participant recruitment	Convenience sampling techniques	N/A	Random sample or census
Sufficient sample size	$N < 100$	$N \geq 100$ and ≤ 999	$N \geq 1000$
Reliable and valid measures of food insecurity	Measures without psychometric testing	Measures with limited testing or tested in different population	Measures with psychometric testing in related population

Table 2.2. Basic characteristics of the studies examining college food insecurity

Author (year) and Reference Type(s)	Study Design (Sampling Strategy)	Study Population	Sample Size (Response Rate)	Demographics	University Setting
Khachadourian, 1999 (45) <i>Thesis</i>	Cross-sectional (Convenience)	Re-entry (> 25 years old) female students	49 (49%)	Sex: 100% female Age: 49% 36-45 years old Race/ethnicity: 41% white, 32% Hispanic Income: NR Employment: NR Fin. Aid: NR Nationality: NR	California State University, Fresno
Chaparro, 2009 (46) <i>Peer-Reviewed Article</i>	Cross-sectional (Random, stratified by classes)	Non-freshmen undergraduate and graduate students	410 (33% of instructors; 99% of students)	Sex: 56% female Age: Average 26 years old Race/ethnicity: 26% white and 43% Asian Income: NR Employment: NR Fin. Aid: NR Nationality: 69% born in US	University of Hawaii at Manoa
Freudenberg, 2011 (47) <i>Report</i>	Cross-sectional (Stratified representative sample)	Undergraduate students	2200 (16%)	Sex: 59% female Age: 66% 18-24 years old Race/ethnicity: 20% white, 30% Hispanic Income: 54% received ≤\$49,999/year Employment: NR ‡ Fin. Aid: NR ‡ Nationality: 58% born in the U.S.	17 community college and 4-year universities (City University of New York)
Magoc, 2012 (48) <i>Thesis</i>	Cross-sectional (Census)	College students	708 (NR)	Sex: 78% female Age: 23.8 ± 7.9 years old Race/ethnicity: 87% white Income: NR Employment: 57% employed Fin. Aid: NR Nationality: NR	Eastern Illinois University
Gonzales, 2013 (49) <i>Thesis</i>	Cross-sectional (Random course selection)	Undergraduate students	62 (NC ‡)	Sex: NR Age: Ranged from 19 to over 25 ‡ Race/ethnicity: NR Income: NR Employment: NR	University of Northern Colorado

Table 2.2 (cont.)

Gaines, 2014 (35); Gaines, 2012 (20) <i>Peer-Reviewed Article; Conference Abstract</i>	Cross-sectional (Convenience and stratified random)	Non-freshmen undergraduate students, 19-25 years old	557 (87% within classrooms)	Fin. Aid: NR Nationality: NR Sex: 76% female Age: Ranged from 19 - 25 years old ‡ Race/ethnicity: 82% white Income: 72% received ≤ \$20K/year Employment: NR ‡ Fin. Aid: 44% received aid Nationality: NC ‡	University of Alabama
Gorman, 2014 (50) <i>Thesis</i>	Cross-sectional (Convenience)	College students, 18-26 years old without spouses or children	298 (NR)	Sex: NR Age: NR Race/ethnicity: NR Income: NR Employment: NR Fin. Aid: NR Nationality: NR	Kent State University
Hanna, 2014 (51) <i>Peer-Reviewed Article</i>	Cross-sectional (Convenience)	College students	67 (NC ‡)	Sex: 61% female Age: 77% aged 18-24 years old Race/ethnicity: 34% white, 30% Asian/Pacific Islander Income: 77% received <\$1000/month Employment: 63% employed ‡ Fin. Aid: 55% received <\$100 aid/month ‡ Nationality: NC ‡	California State University - Sacramento (assumed)
Koller, 2014 (52) <i>Thesis</i>	Cross-sectional (Random course selection)	College students, excluding those in study abroad experiences	53 (11%)	Sex: 72% Female Age: 92% aged 18-22 y/o Race/ethnicity: 77% white Income: 48% received <\$10000/year Employment: 34% employed at least part time Fin. Aid: NR Nationality: NR	Bowling Green State University
Patton-López, 2014 (53) <i>Peer-Reviewed Article</i>	Cross-sectional (Census)	College students	354 (7%)	Sex: 73% female Age: 72% aged 18-24 years old Race/Ethnicity: 8% Latino Income: 79% received < \$15,000/year Employment: 50% employed Fin. Aid: 76% received aid Nationality: NR	Western Oregon University (assumed)

Table 2.2 (cont.)

Davidson, 2015 (54) <i>Conference Abstract</i>	Cross-sectional (Convenience)	Undergraduate students enrolled in a nutrition course, 18-24 years old	211 (51%)	Sex: 84% female Age: NR Race/ethnicity: 89% white ‡ Income: NR Employment: NR Fin. Aid: 67% received aid Nationality: NR	University of New Hampshire
Fossman, 2015 (38); Lindsley, 2014 (23) <i>Report; Conference Abstract</i>	Longitudinal (Census)	College students living on a university campus	65 (8%)	Sex: 55% female Age: Average 21.6 ± 4.6 years old Race/ethnicity: 83.3% white Income: NC ‡ Employment: NR ‡ Fin. Aid: NC ‡ Nationality: NC ‡	University of Alaska, Anchorage, AK ‡
Maroto, 2015 (36); Maroto, 2013 (21) <i>Peer-Reviewed Article; Dissertation</i>	Cross-sectional (Convenience)	Community college students (urban and suburban)	301 (62%)	Sex: 55% female Age: Average 23 years old Race/ethnicity: 71% African-American Income: 72% received ≤\$750/month Employment: NC Fin. Aid: NC Nationality: NC	NR, 2 Maryland community colleges
Shelnutt, 2015 (55) <i>Conference Abstract</i>	Cross-sectional (Census)	Undergraduate and graduate students	1891 (NR)	Sex: NR Age: NR Race/ethnicity: NR Income: NR Employment: NR Fin. Aid: NR Nationality: NR	University of Florida (assumed)
Silva, 2015 (56) <i>Peer-Reviewed Article</i>	Cross-sectional (Random, stratified by classes)	Undergraduate and graduate students	390 (2%)	Sex: 60% female Age: 56% between 18-22 years old Race/ethnicity: 43% white, 26% Asian Income: NR Employment: 73% employed ‡ Fin. Aid: 62% received aid ‡ Nationality: NR	University of Massachusetts - Boston
Bianco, 2016 (57) <i>Report</i>	Cross-sectional (Random)	College students	707 (13%)	Sex: NR Age: NR Race/ethnicity: 55% white Income: NR Employment: NR	California State University, Chico

Table 2.2 (cont.)

Bruening, 2016 (58) <i>Peer-Reviewed Article</i>	Cross-sectional (Convenience)	Freshman college students	209 (42%)	Fin. Aid: NR Nationality: NR Sex: 62% female Age: 18.8 average \pm 0.5 years old Race/Ethnicity: 46% white, 27% Hispanic Income: NC ‡ Employment: 71% unemployed ‡ Fin. Aid: 73% received Pell Grants Nationality: 6% international students ‡	Arizona State University (assumed)
Calvez, 2016 (59) <i>Peer-Reviewed Article</i>	Cross-sectional (Convenience)	Undergraduate students	205 ‡ (1% ‡)	Sex: 62% female Age: NR ‡ Race/ethnicity: NC ‡ Income: NC ‡ Employment: NC ‡ Fin. Aid: NC ‡ Nationality: NC ‡	Texas A&M University
Dubick, 2016 (60) <i>Report</i>	Cross-sectional (Convenience)	Undergraduate students	3765 (NC ‡)	Sex: 57% female Age: 69% aged 18-21 years old Race/ethnicity: 40% white, 19% Asian Income: 55% received \leq \$49,999/year Employment: NR, but collected ‡ Fin. Aid: 43% Pell Grant eligible Nationality: 87% US citizen	34 institutions; 8 community colleges and 26 4-year universities in 12 states
MacDonald, 2016 (61) <i>Thesis</i>	Cross-sectional (Convenience)	Fulbright College of Arts/ Sciences students living on a university campus	467 (7%)	Sex: 71% female Age: Average 23.2 \pm 7.7 years old Race/ethnicity: 79% white Income: NC ‡ Employment: 58% employed at least part-time Fin. Aid: NC ‡ Nationality: NC ‡	University of Arkansas
Maguire, 2016 (62) <i>Report</i>	Cross-sectional (Census)	Undergraduate and graduate students	1554 (18% ‡)	Sex: 67% ‡ Age: Average 24 \pm 7 years old ‡ Race/ethnicity: 61% white ‡ Income: NR Fin. Aid: NR Employment: NR Nationality: NR	Humboldt State University
Mirabatur, 2016 (63) <i>Peer-Reviewed Article</i>	Cross-sectional (Random)	Undergraduate, graduate and non-degree-seeking students	514 (7%)	Sex: 53% female (weighted) Age: NR Race/ethnicity: 75% white (weighted)	University of Michigan (assumed)

Table 2.2 (cont.)

Morris, 2016 (37); Morris, 2014 (22) <i>Peer-Reviewed Article; Thesis</i>	Cross-sectional (Census)	Undergraduate students	1882 (4%)	Income: NR Employment: NR Fin. Aid: NR Nationality: NR Sex: 67% female Age: NR Race/ethnicity: 77% white Income: NR Employment: 64% employed at least part-time Fin. Aid: 64% and 70% received aid that did or did not require repayment, respectively	Eastern Illinois, Northern Illinois, Southern Illinois, & Western Illinois Universities
Twill, 2016 (64) <i>Peer-Reviewed Article</i>	Cross-sectional (Convenience)	College students	nearly 150 (NC ‡)	Nationality: NR Sex: NC ‡ Age: NC ‡ Race/ethnicity: NC ‡ Income: NC ‡ Employment: NC ‡ Fin. Aid: NC ‡ Nationality: NC ‡	Wright State University
Wood, 2016 (65) <i>Report</i>	Cross-sectional (NR)	Community college students	3647 (NR)	Sex: NR Age: NR Race/ethnicity: 31% white, 37.9% Latino Income: NR Employment: NR Fin. Aid: NR Nationality: NR	California Community Colleges (# and names: NR)
Adamovic, 2017 (66) <i>Thesis</i>	Cross-sectional (Convenience)	College students	339 (1%)	Sex: 77% female Age: NC ‡ Race/ethnicity: 55% white Income: NC ‡ Employment: 70% employed at least part time Fin. Aid: 56% and 44% received aid that does not and does require repayment, respectively Nationality: NC ‡	University of Colorado - Boulder
Blagg, 2017 – 2 yr students (19) <i>Report</i>	Cross-sectional (Stratified representative sample)	Households with student enrolled at undergraduate level	3,345 (76- 88% month- over-month ‡)	Sex: 54% Female Age: 68% between 18-25 years old Race/ethnicity: 51% white Income: NR Employment: NR	No specific universities under study

Table 2.2 (cont.)

Blagg, 2017 – 4 yr students (19) <i>Report</i>	Cross-sectional (Stratified representative sample)	Households with student enrolled at undergraduate level	7,035 (76-88% month-over-month ‡)	Fin. Aid: NR Nationality: NR Sex: 54% female Age: 77% between 18-25 years old Race/ethnicity: 61% white Income: NR Employment: NR Fin. Aid: NR Nationality: NR	No specific universities under study
Ellis, 2017 (67) <i>Conference Abstract</i>	Cross-sectional (Convenience ‡)	Undergraduate students	344 (NC ‡)	Sex: 87% female Age: Average 19 years old Race/ethnicity: 80% white ‡ Income: NC ‡ Employment: NC ‡ Fin. Aid: NC ‡ Nationality: NC ‡	University of Alabama
Hillmer, 2017 (68) <i>Conference Abstract</i>	Cross-sectional (Random course selection)	Undergraduate students	197 (NR)	Sex: NR Age: NR Race/ethnicity: NR Income: NR Employment: NR Fin. Aid: NR Nationality: NR	Southeast Missouri State University (assumed)
Holland, 2017 (69) <i>Conference Abstract</i>	Cross-sectional (Convenience)	Undergraduate and graduate students	629 (10%‡)	Sex: 73% female Age: Average 21.2 ± 4.4 years old Race/ethnicity: NR Income: NR Employment: NR Fin. Aid: NR Nationality: NR	Winthrop University ‡
Kashuba, 2017 (70) <i>Thesis</i>	Cross-sectional (Convenience)	College students	1236 (≥ 7%)	Sex: 73% female Age: NR Race/ethnicity: 70% white Income: NR Employment: NR Fin. Aid: NR Nationality: NR	University of Oregon
King, 2017 (71) <i>Dissertation</i>	Cross-sectional (Census)	College students, excluding those in online-only program	4188 (14%)	Sex: 73% female Age: 84% between 18-24 years old Race/ethnicity: 79% white	Kent State University

Table 2.2 (cont.)

Knol, 2017 (72) <i>Peer-Reviewed Article</i>	Cross-sectional (Census)	College students aged ≥ 19 years old and living off-campus. Excluded if pregnant, ate at Greek Fraternity/Sorority houses, living with parents, married, or followed a restricted diet	351 (~3%)	Income: NR Employment: 62% employed at least part-time Fin. Aid: 66% received aid Nationality: 6% international students Sex: 72% female Age: All ≥ 19 years old Race/ethnicity: 85% white Income: NR Employment: 47% employed Fin Aid: 62% owed 0-\$999 in aid Nationality: NC ‡	University of Alabama
Martinez, 2017 (39); Martinez, 2016 (25); Martinez, 2016 (24) <i>Peer-Reviewed Article; Report; Conference Abstract</i>	Cross-sectional (Random)	Undergraduate and graduate students	8705 (13%)	Sex: 67% female Age: Average 23 ± 6 years old Race/ethnicity: 34% white, 31% Asian Income: NC ‡ Employment: NC ‡ Fin. Aid: 65% received aid Nationality: 9% international students	10 University of California campuses
McArthur, 2017 (40); Danek, 2017 (28) <i>Peer-Reviewed Article; Thesis</i>	Cross-sectional (Random)	Non-freshmen undergraduate and graduate students	1093 (18%)	Sex: 68% female Age: Average 21.7 ± 3.8 years old Race/ethnicity: 92% white Income: 77 received $< \$500$ /month Employed: 63% employed at least part-time Financial Aid: 64% received aid Nationality: $< 1\%$ international students	Appalachian State University ‡
Mercado, 2017 (73) <i>Dissertation</i>	Cross-sectional (Census)	Community college students	693 (3%)	Sex: 70% female Age: Average 29.5 ± 11.1 years old Race/ethnicity: 29% white, 22% Hispanic Income: 55% received $\leq \$25,000$ /year Employment: 61% employed Fin. Aid: 45% received aid Nationality: 14% non-US citizen or resident	Peralta Community College District (4 colleges)
Miles, 2017 (74) <i>Peer-Reviewed Article</i>	Cross-sectional (Census)	Undergraduate and graduate students enrolled in the School of Social Work	496 (55%)	Sex: 86% female Age: 47% between 25-34 years old Race/ethnicity: 20% person of color; 12% Hispanic Income: NR Employment: NR Fin. Aid: NR Nationality: NR	Portland State University (assumed)

Table 2.2 (cont.)

Payne-Sturges, 2017 (75) <i>Peer-Reviewed Article</i>	Cross-sectional (Convenience)	Undergraduate students	237 (62%)	Sex: 81% female Age: Average 20.7 ± 4.5 years old Race/ethnicity: 49% white, 20% Black Income: 58% received ≥ \$70,000/year Employment: 61% employed Fin. Aid: 64% received aid Nationality: 20% born outside of U.S. ‡	University of Maryland (assumed)
Poll, 2017 (76) <i>Conference Abstract</i>	Cross-sectional (NR)	NCAA Division 1 male college athletes	93 (NR)	Sex: 100% male Age: Average 19.7 ± 1.4 years old Race: 48% white, 41% Black Income: NR Employment: NR Fin. Aid: NR Nationality: NR	University of Mississippi (assumed)
Wall-Bassett, 2017 (77) <i>Conference Abstract</i>	Cross-sectional (NR)	College students	381 (94%)	Sex: NR Age: NR Race/ethnicity: NR Income: NR Employment: NR Fin. Aid: NR Nationality: NR	Western Carolina University (assumed)
West, 2017 (78) <i>Thesis</i>	Cross-sectional (NR)	Latinx undergraduate students in an academic department with 97% Latinx enrollment	50 (25%)	Sex: 82% female Age: Between 18-27 years old Race/ethnicity: 100% Latinx Income: NR Employment: 78% employed Fin. Aid: 50% received work-study Nationality: NR	University of California - Davis
Broton, 2018 – Study 1 (18); Goldrick-Rab, 2017 (32) <i>Peer-Reviewed Article; Report</i>	Cross-sectional (Convenience)	Community college undergraduate students	26,131 (4%)	Sex: 72% Female Age: Average 27.7 years old Race/ethnicity: 44% white, 24% Hispanic Income: NR Employment: NR Fin. Aid: NR Nationality: NR	73 community colleges in 24 states
Broton, 2018 – Study 2 (18); Goldrick-Rab, 2015 (29) <i>Peer-Reviewed Article; Report</i>	Cross-sectional (Convenience)	Community college undergraduate students	4185 (9%)	Sex: 55% female Age: Average 29.8 years old Race/ethnicity: 55% white Income: 44% received <\$50,000/year Employment: 62% employed in last week	10 community colleges in 7 states

Table 2.2 (cont.)

Broton, 2018 – Study 3 (18); WI HOPE Lab, 2016 (34) <i>Peer-Reviewed Article; Report</i>	Cross-sectional (Convenience)	Freshman and Sophomore students. To be eligible, had an EFC \leq 200% of the Pell Grant eligibility, had unmet financial need, and had an interest in a STEM field, would require remediation in math	1007 (64%)	Fin. Aid: 67% received aid Nationality: 95% U.S. citizen Sex: 49.7% female Age: Average 19.4 years old Race/ethnicity: 79.0% white Income: 42.9% earned $<$ \$50,000/year Employment: NR Fin. Aid: 100% received aid Nationality: NR	10 public and private 2- and 4-year colleges in WI
Broton, 2018 – Study 4 (18); Broton, 2014 (26); Goldrick-Rab, 2016 (27) <i>Peer-Reviewed Article; Report; Book</i>	Cross-sectional, part of larger longitudinal study (Stratified representative sample)	Undergraduate students who were WI residents, within 3 years of completing high school, qualified for a Pell Grant and had unmet financial need of at least \$1	1442 (77%)	Sex: 60% female Age: Average 18.4 years old Race/ethnicity: 71% white Income: 88% received $<$ \$50,000/year Employment: NR Fin. Aid: 100% received aid Nationality: NR	42 public 2- and 4-year Wisconsin colleges and universities
Bruening, 2018 (79) <i>Peer-Reviewed Article</i>	Longitudinal (Convenience)	Freshman undergraduate students living in residence halls	1,138 (NR)	Sex: 65% female Age: NR Race/Ethnicity: 51% white Income: NR Employment: NR Fin. Aid: 33% received Pell Grants Nationality: NR	Arizona State University (assumed)
Crutchfield, 2018 (80) <i>Report</i>	Cross-sectional (Census)	College students	24,324 (6%)	Sex: 72% female Age: Average 23.6 years old Race/ethnicity: 53.9% white Income: NR Employment: NC Fin. Aid: NC Nationality: NC	23 CSU campuses
Hagedorn, 2018 (41); Hagedorn, 2017 (33) <i>Peer-Reviewed Article; Conference Abstract</i>	Cross-sectional (Census of all courses)	Undergraduate and graduate students	692 (2%)	Sex: 71% female Age: Average 21.3 ± 4 years old Race/ethnicity: 87% white Income: NR ‡ Employment: 54% employed Fin. Aid: 80% received aid Nationality: 5% international students ‡	West Virginia University
McArthur, 2018 (81) <i>Peer-Reviewed Article</i>	Cross-sectional (Random)	Freshmen undergraduate students	456 (23%)	Sex: 73% female Age: Average 18.5 ± 1.0 years old Race/ethnicity: 83% white	Appalachian State University ‡

Table 2.2 (cont.)

<p>El Zein, n.d. (42); El Zein, 2017 (31); Laitner, 2016 (30) <i>Article in Preparation; Conference Abstract; Conference Abstract</i></p>	<p>Cross-sectional (Convenience ‡)</p>	<p>Freshmen undergraduate students, consuming <2 cups of fruits or <3 cups of vegetables daily, and meeting one of the following criteria (body mass index ≥ 25 kg/m², first-generation college student, parent that is overweight or obese, low-income background, or identify as a racial minority.)</p>	<p>859 (NC ‡)</p>	<p>Income: 97% received < \$500/month Employed: 21.4% employed Financial Aid: 68% received aid Nationality: NR ‡ Sex: 67% female Age: 62% aged 19 years old Race/ethnicity: 62% white Income: NR Employment: 43% employed at least part time Fin. Aid: 40% received Pell Grants Nationality: NR</p>	<p>Auburn University, University of Florida, Syracuse University, University of Tennessee, University of Maine, South Dakota State University, West Virginia University, and Kansas State University</p>
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Note. NR=Not Reported, NC=Not Collected, ‡=Information provided by author(s), Fin. Aid=Financial Aid. Sixty-six study citations are included in the table with sixty-two independent records (i.e., publications) reporting on fifty-one distinct study samples. These study samples were identified by separating records that included more than one study or sample as well as condensing multiple records reporting on the same study.

Table 2.3. Assessment protocol characteristics of the studies examining college food insecurity

Author (year)	Food insecurity survey	Food insecurity reference period	Food insecurity survey modality	Food insecurity prevalence
Khachadourian, 1999 (45)	USDA Household FSSM, 18 items	12 months	In-person; Mail	43%
Chaparro, 2009 (46)	USDA Adult FSSM, 10 items	12 months	In-class	21%
Freudenberg, 2011 (47)	Modified USDA FSSM, 4 items	12 months	Online; Phone	39%
Magoc, 2012 (48)	USDA Short Form FSSM, 6 items	3 months	Online	41%
Gonzales, 2013 (49)	USDA Adult FSSM, 10 items	12 months	Online	44% ‡
Gaines, 2014 (35); Gaines, 2012 (20)	USDA Adult FSSM, 10 items	12 months	In-class	14%
Gorman, 2014 (50)	USDA Adult FSSM, 10 items	12 months	Online	32%
Hanna, 2014 (51)	Modified USDA FSSM with 1-item screener ‡	12 months	Online	19%
Koller, 2014 (52)	Gave food insecurity definitions and asked students to select	None	Online	19%
Patton-López, 2014 (53)	USDA Short Form FSSM, 6 items	12 months	Online	59%
Davidson, 2015 (54)	USDA Short Form FSSM, 6 items	12 months	Online	12% ‡
Fossmann, 2015 (38); Lindsley, 2014 (23)	USDA Short Form FSSM, 6 items ‡	4 months ‡	Online ‡	55% in summer & 78% in fall
Maroto, 2015 (36); Maroto, 2013 (21)	USDA Adult FSSM, 10 items	12 months	In-person	56%
Shelnutt, 2015 (55)	USDA FSSM, items NR	NR	Online	10%
Silva, 2015 (56)	Modified USDA FSSM, 4 items	12 months	In-person	28% ‡
Bianco, 2016 (57)	USDA Short Form FSSM, 6 items	12 months	Online	46%
Bruening, 2016 (58)	Adapted screener, 2 items	1 month; 3 months	Online	32% in 1-month; 37% in 3 months
Calvez, 2016 (59)	USDA Short Form FSSM, 6 items	“during the semester at TAMU”	Online	48%
Dubick, 2016 (60)	USDA Adult FSSM, 10 items	30 days	Online	48%
MacDonald, 2016 (61)	Modified USDA FSSM, 8 items	12-month	Online	40%
Maguire, 2016 (62)	USDA Short Form FSSM, 6 items	30 days	Online	53%
Mirabitur, 2016 (63)	USDA Short Form FSSM, 6 items	12-months	Online	41% (weighted)
Morris, 2016 (37); Morris, 2014 (22)	USDA Adult FSSM, 10 items	9- months	Online	35%
Twill, 2016 (64)	Gave food insecurity definitions and asked students to select ‡	12 months ‡	Online	48%
Wood, 2016 (65)	Stressful life events scale	NR	NR	12%
Adamovic, 2017 (66)	USDA Short Form FSSM, 6 items	12- mo.	Online	54%
Blagg, 2017 – 2 yr students (19)	USDA Household FSSM, 18 items	12 months	Phone	17%

Table 2.3 (cont.)

Blagg, 2017 – 4 yr students (19)	USDA Household FSSM, 18 items	12 months	Phone	11%
Ellis, 2017 (67)	USDA Short Form FSSM, 6 items	30 days ‡	Online ‡	58% ‡
Hillmer, 2017 (68)	USDA FSSM, items NR	NR	NR	38%
Holland, 2017 (69)	USDA Adult FSSM, 10 items ‡	12 months	Online; In-person	48%
Kashuba, 2017 (70)	USDA Short Form FSSM, 6 items	30 days	Online	52%
King, 2017 (71)	USDA Adult FSSM, 10 items	3 months	Online	36%
Knol, 2017 (72)	USDA Adult FSSM, 10 items	12 months	Online	37%
Martinez, 2017 (39); Martinez, 2016 (25); Martinez, 2016 (24)	USDA Short Form FSSM, 6 items	12-months	Online	42% (weighted)
McArthur, 2017 (40); Danek, 2017 (28)	USDA Adult FSSM, 10 items	12 months	Online	46%
Mercado, 2017 (73)	USDA Short Form FSSM, 6 items	30 days	Online	61%
Miles, 2017 (74)	Modified USDA HFSSM, 15 items	12 months	Online	43%
Payne-Sturges, 2017 (75)	USDA Household FSSM, 18 items	12 months	Online	15%
Poll, 2017 (76)	USDA FSSM, items NR	r/t high school	NR	16%
Wall-Bassett, 2017 (77)	USDA FSSM, items NR	NR	Online	38%
West, 2017 (78)	USDA Adult FSSM, 10 items	12 months	Online	75%
Broton, 2018 – Study 1 (18); Goldrick-Rab, 2017 (32)	USDA Short Form FSSM, 6 items	30 days	Online	56%
Broton, 2018 – Study 2 (18); Goldrick-Rab, 2015 (29)	USDA Short Form FSSM, 6 items	30 days	Online	39%
Broton, 2018 – Study 3 (18); WI HOPE Lab, 2016 (34)	USDA Short Form FSSM, 6 items	12 months	Online; NR ‡	51%
Broton, 2018 – Study 4 (18); Broton, 2014 (26); Goldrick-Rab, 2016 (27)	Adapted screener, 1 item	30 days	Online; Mail	57%
Bruening, 2018 (79)	USDA Short Form FSSM, 6 items	30 days	Online	28%
Crutchfield, 2018 (80)	USDA Adult FSSM, 10 items	30 days	Online	42%
Hagedorn, 2018 (41); Hagedorn, 2017 (33)	USDA Adult FSSM, 10 items	12 months	Online	37%
McArthur, 2018 (81)	USDA Adult FSSM, 10 items	Previous academic year at school	Online	22%
El Zein, n.d. (42); El Zein, 2017 (30); Laitner, (30)	USDA Adult FSSM, 10 items	12 months	In-person	19%

Note. USDA=United States Department of Agriculture, FSSM=Food Security Survey Module, NR=Not Reported, NC=Not Collected, ‡=Information provided by author(s). Sixty-six study citations are included in the table with sixty-two independent records (i.e., publications) reporting on fifty-one distinct study samples. These study samples were identified by separating records that included more than one study or sample as well as condensing multiple records reporting on the same study.

Table 2.4. Quality assessments of the studies examining college food insecurity

Author(s), year	A priori aim/hypothesis	Study population clearly specified	Participant recruitment	Sample size	Reliable/valid FI surveys	Mean Overall Score
Khachadourian, 1999 (45)	2	2	0	0	2	6
Chaparro, 2009 (46)	2	2	2	1	1	8
Freudenburg, 2011 (47)	2	2	2	2	1	9
Magoc, 2012 (48)	2	1	2	1	1	7
Gonzales, 2013 (49)	1	1	2	0	1	5
Gaines, 2014 (35); Gaines, 2012 (20)	2	2	0	1	1	6
Gorman, 2014 (50)	2	2	0	1	1	6
Hanna, 2014 (51)	2	0	0	0	1	3
Koller, 2014 (52)	2	2	2	0	0	6
Patton-López, 2014 (53)	2	1	2	1	1	7
Fossman, 2015 (38); Lindsley, 2014 (23)	2	2	2	0	1	7
Maroto, 2015 (36); Maroto, 2013 (21)	2	2	0	1	1	6
Silva, 2015 (56)	2	1	2	1	0	6
Bianco, 2016 (57)	2	2	2	1	1	8
Bruening, 2016 (58)	2	2	0	1	1	6
Calvez, 2016 (59)	2	1	0	1	1	5
Dubick, 2016 (60)	2	1	0	2	1	6
MacDonald, 2016 (61)	2	2	0	1	0	5
Maguire, 2016 (62)	2	0	2	2	1	7
Mirabitor, 2016	2	2	2	1	1	8
Morris, 2016 (37); Morris, 2014 (22)	2	2	2	2	1	9
Twill, 2016 (64)	2	1	0	1	NR	4
Wood, 2016 (65)	2	1	NR	2	NR	5
Adamovic, 2017 (66)	2	1	0	1	1	5
Blagg, 2017 -both 2-yr and 4-yr samples (19)	2	2	2	2	1	9
Kashuba, 2017 (70)	2	1	0	2	1	6
King, 2017 (71)	2	2	2	2	1	9
Knol, 2017	2	2	2	1	1	8
Martinez, 2017 (39); Martinez, 2016 (25); Martinez, 2016 (24)	2	1	2	2	1	8
McArthur, 2017 (40); Danek, 2017 (28)	2	2	2	2	1	9
Mercado, 2017 (73)	2	2	2	1	1	8
Miles, 2017 (74)	2	2	2	1	1	8
Payne-Sturges, 2017 (75)	2	2	0	1	1	6
West, 2017 (78)	2	2	NR	0	1	5

Table 2.4 (cont.)

Broton, 2018 – Study 1 (18); Goldrick-Rab, 2017 (32)	2	1	2	2	1	8
Broton, 2018 – Study 2 (18); Goldrick-Rab, 2015 (29)	2	1	2	2	1	8
Broton, 2018 – Study 3 (18); WI HOPE Lab, 2016 (34)	2	2	2	2	1	9
Broton, 2018 – Study 4 (18); Broton, 2014 (26); Goldrick- Rab, 2016 (27)	2	2	2	2	1	9
Bruening, 2018 (79)	2	1	0	2	1	6
Crutchfield, 2018 (80)	2	1	2	2	1	8
Hagedorn, 2018 (41); Hagedorn, 2017 (33)	2	1	2	1	1	7
McArthur, 2018 (81)	2	2	2	1	1	8
El Zein, n.d. (42); El Zein, 2017 (31); Laitner, 2016 (30)	2	2	0	1	1	6
Criteria Mean Scores	1.98	1.53	1.27	1.23	0.95	6.86
Criteria SD	0.15	0.59	0.98	0.68	0.31	1.54

Note. FI=Food Insecurity, NR=Not Reported, SD=Standard Deviation. Scoring criteria for each quality assessment component are reported in Table 2.1. Fifty-nine study citations are included in the table with fifty-six independent records (i.e., publications) reporting on forty-three distinct studies. These study samples were identified by separating records that included more than one study, condensing multiple records reporting on the same study, and removing studies that were only published as an abstract.

Table 2.5. Sub-group meta-analyses of studies examining food insecurity

Factor	Included students (n)	Food insecurity prevalence (95% CI)	P-value
<i>Sampling Strategy</i>			
Convenience, n=21	42,383	.39 (.32, .45)	0.354
Census, n=14	38,168	.40 (.33, .48)	0.268
Random, n=8	11,617	.36 (.29, .42)	0.710
Non-probabilistic representative, n=4	14,022	.31 (.14, .48)	Ref
<i>Food Security Survey</i>			
USDA Adult FSSM, n=16	39,917	.37 (.33, .42)	0.017
USDA Short Form FSSM, n=17	48,096	.46 (.41, .52)	<0.001
USDA Household FSSM, n=4	10,666	.17 (.12, .22)	Ref
New/Other Assessments, n=10	9,120	.34 (.21, .47)	0.096
<i>Survey Reference Period</i>			
Less than twelve months, n=16	72,069	.46 (.41, .51)	Ref
Twelve months, n=28	31,574	.37 (.30, .43)	0.039
<i>Student Class Composition</i>			
Undergraduate only, n=27	60,655	.35 (.27, .44)	Ref
Undergraduate and Graduate, n=21	49,111	.40 (.34, .45)	0.355
<i>Institution Type</i>			
University, n=41	63,645	.36 (.31, .41)	Ref
Community college, n=7	42,067	.41 (.25, .58)	0.441
University and community college, n=3	4,649	.48 (.38, .60)	0.178
<i>Institution Scope</i>			
Single institution, n=36	20,840	.37 (.32, .43)	Ref
Multiple institutions, n=12	75,494	.45 (.40, .51)	0.096

Note. The impact of each variable on the estimated food insecurity prevalence was tested using meta-analysis random effects regression models. Studies with missing data for the sub-group categories of interest were not included in the respective sub-group analyses. Studies which reported using the USDA FSSM without specifying subtype or modifications (n=4) were not included in the survey subgroup analysis due to ambiguity. New/Other Assessments included modified FSSM protocols, providing food security definitions, sufficiency screeners, and the stressful life events scale.

Figure 2.1. Study Selection Flow Diagram

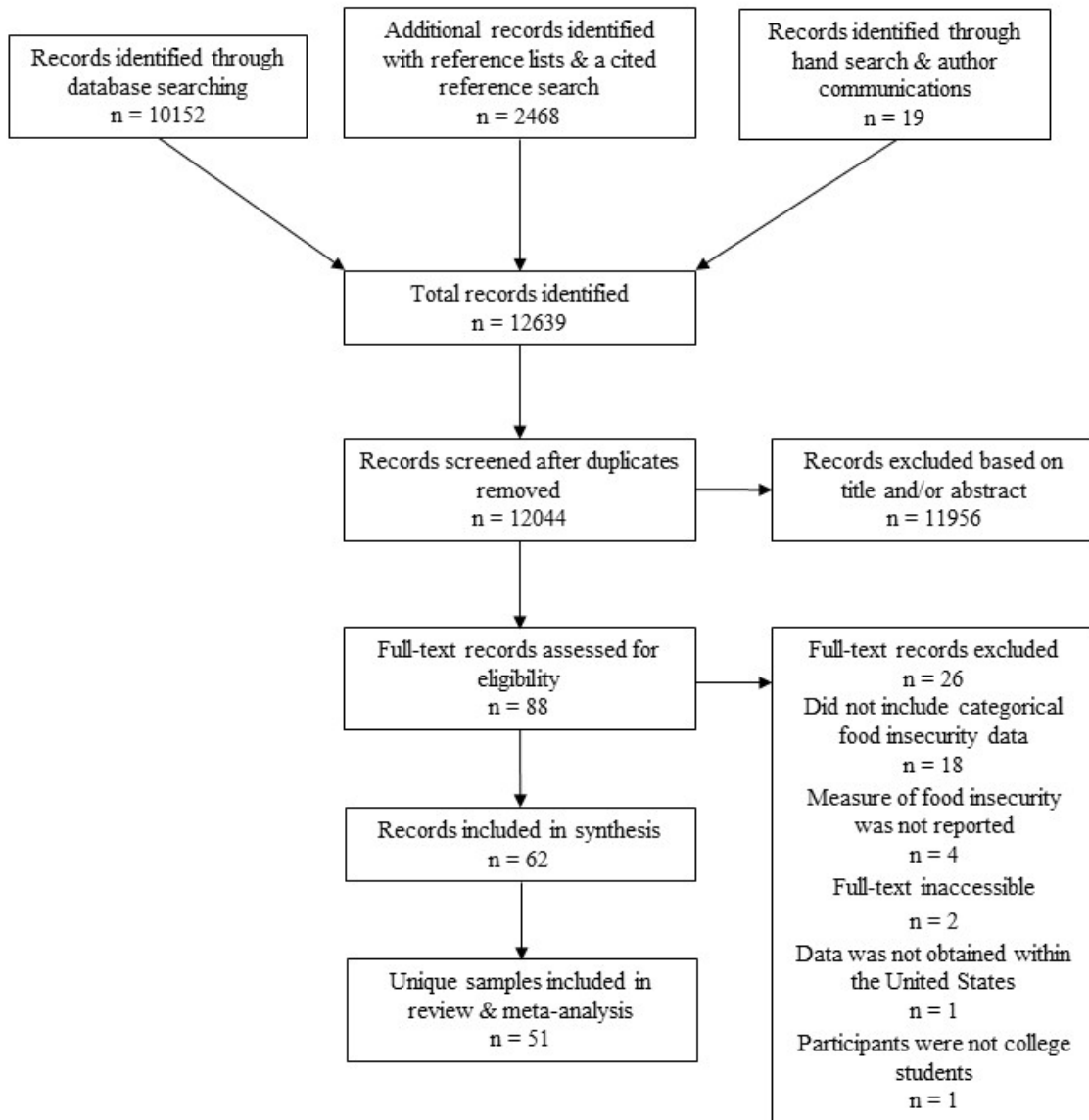


Figure 2.2. Forest plot of the prevalence of food insecurity from a meta-analysis (random effects model). The final row indicates the overall prevalence (effect size) estimate of 38%. Abbreviation: CI= Confidence Interval.

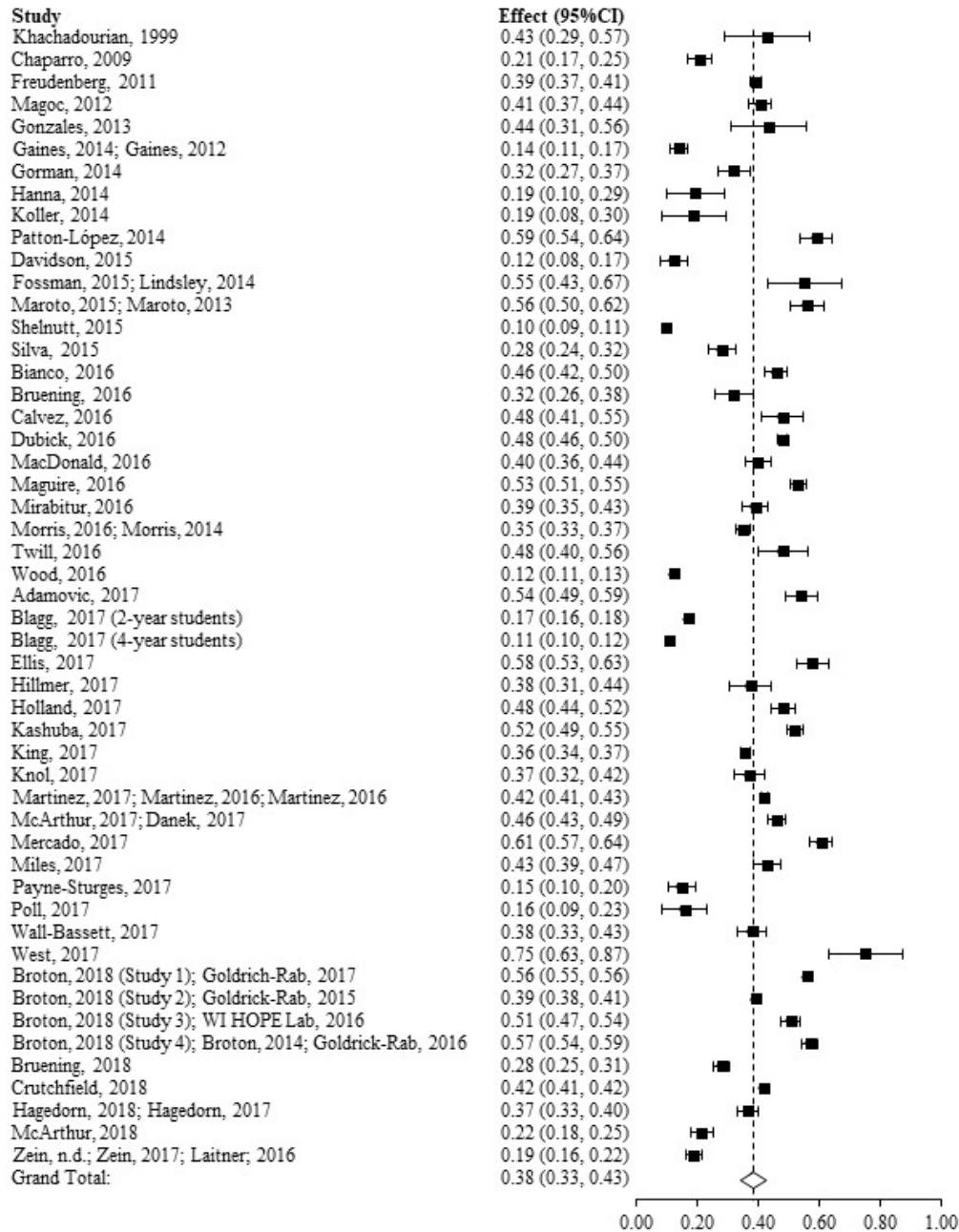
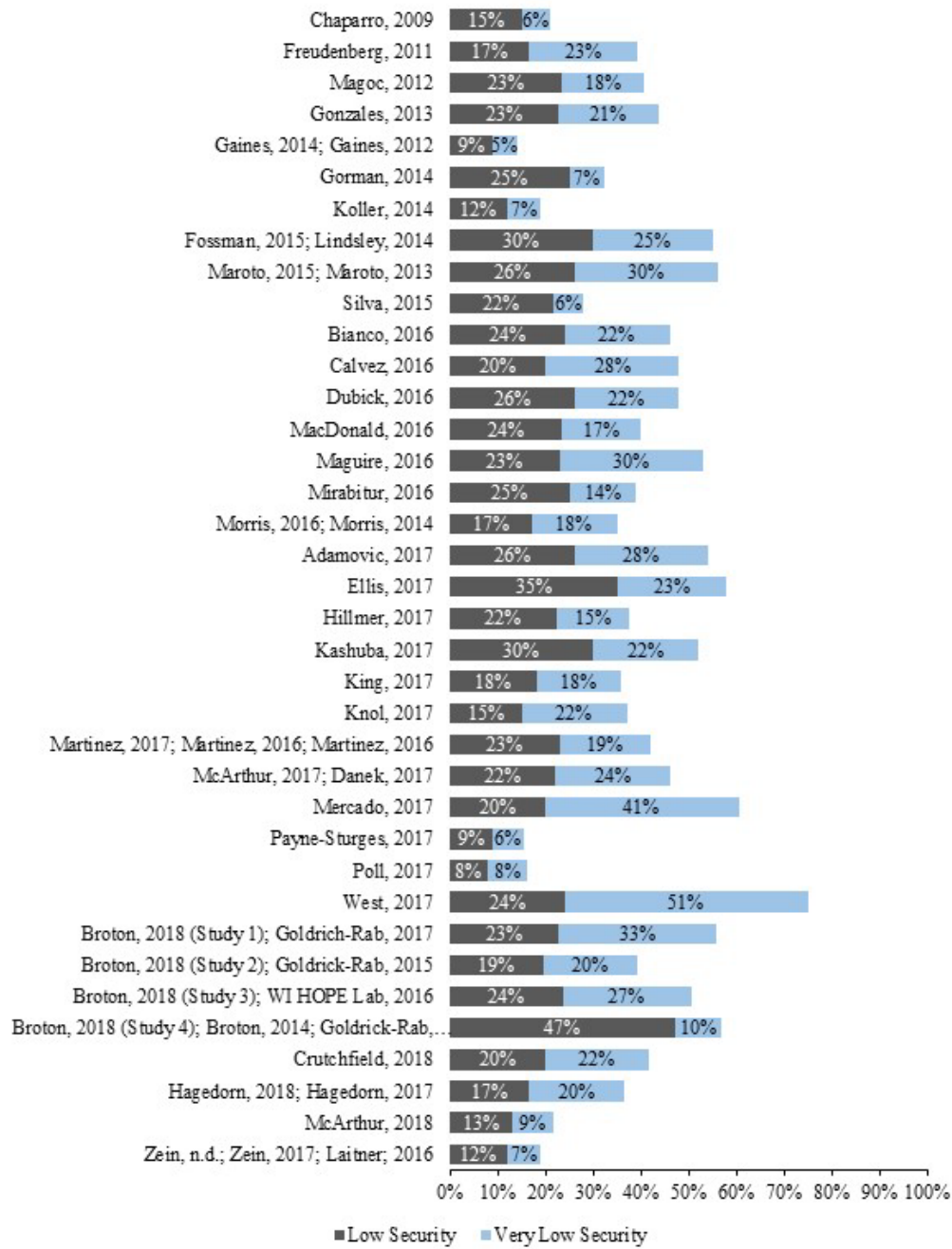


Figure 2.3. Prevalence of low and very low food security in meta-analysis of studies of college students. Studies that did not report low and very low food security rates are not shown.



CHAPTER 3: ARE ESTIMATES OF FOOD INSECURITY AMONG COLLEGE STUDENTS ACCURATE? COMPARISON OF ASSESSMENT PROTOCOLS²

Abstract

A growing body of literature suggests that post-secondary students experience food insecurity (FI) at greater rates than the general population. However, these rates vary dramatically across institutions and studies. FI assessment methods commonly used in studies with college students have not been scrutinized for psychometric properties, and varying protocols may influence resulting FI prevalence estimates. The objective of this study was to assess the performance of standard food security assessment protocols and to evaluate their agreement as well as the relative accuracy of these protocols in identifying FI students. A randomized sample of 4,000 undergraduate students were invited to participate in an online survey (Qualtrics, LLC, Provo, Utah, USA) that evaluated sociodemographic characteristics and FI with the 2-item food sufficiency screener and the 10-item USDA Adult Food Security Survey Module (FSSM; containing the abbreviated 6-item module). Four hundred sixty-two eligible responses were included in the final sample. The psychometric analysis revealed inconsistencies in college student response patterns on the FSSM when compared to national evaluations. Agreement between FI protocols was generally high (>90%) but was lessened when compared with a protocol that incorporated the 2-item screener. The 10-item FSSM with the 2-item screener had the best model fit (McFadden's $R^2=0.15$ and Bayesian Information Criterion=-2049.72) and emerged as the tool providing the greatest relative accuracy for identifying students with FI. Though the 10-item FSSM and 2-item screener yields the most accuracy in this sample, it is

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unknown why students respond to FSSM items differently than the general population. Further qualitative and quantitative evaluations are needed to determine which assessment protocol is the most valid and reliable for use in accurately identifying FI in post-secondary students across the U.S.

Introduction

A rapidly growing body of literature has developed on the topic of food insecurity (FI), defined as the unavailability of sufficient food, among post-secondary students. Recent reviews estimate that 32.9% to 50.9% of college students in the U.S. experience FI [1,2]. Compared to the 2016 U.S. estimate indicating 12.3% of American households experience FI [3], students seem to be more susceptible to FI. This is concerning, as evidence suggests that FI among adults is associated with lower quality dietary patterns [4-6], more mental health concerns [7,8], diminished physical health [9,10], and greater risk for chronic diseases [11,12]. Studies conducted specifically in college settings indicate that students who identify as FI are more likely to have lower quality dietary patterns, physical health status, and academic success [2]. Though the culmination of findings from studies on university campuses indicate FI is a prevalent issue among college students, the evidence is hindered by limited psychometric testing of food security questionnaires used and thus, related concerns about accuracy in reported estimates.

A variety of assessment procedures have been used to characterize the prevalence of FI among college students. Some studies have used novel questionnaires, such as providing the definitions of food security levels [13,14], evaluating FI on a single item [15,16], using selected items from pre-existing tools [17-21], or making various modifications to standard surveys [22-24]. The primary concern regarding estimates from these reports is that their precision and

accuracy in identifying students with FI are unknown. However, the vast majority of studies exploring FI among college students have used the United States Department of Agriculture (USDA) Food Security Survey Modules (FSSM) [25], with several studies utilizing the abbreviated 6-item [15,26-40] and the full individual adult 10-item [41-55] or 18-item household versions [56,57].

Using USDA FSSMs when assessing college students for FI has advantages. The FSSMs were tested extensively when they were originally developed throughout the 1990s, using rhetorical arguments [58,59] as well as qualitative [60] and quantitative evidence [60-63]. Since initial development, the FSSMs have been used widely to evaluate domestic food security prevalence, nationally and locally. This widespread adoption allows for FI estimates to be easily compared across locations, time points, and populations. Therefore, recent studies using the FSSMs when evaluating FI in college students are applying some of the strongest assessment tools available for estimating FI domestically.

Despite the strength of evidence supporting the use of FSSMs, evaluation of their appropriateness for college student populations has not been conducted, as has been the practice for adaptation of other survey instruments to sub-populations [64-67]. There are two critical methodological questions related to FI that warrant evaluation. Broadly, it is worthwhile to know if the FSSMs are appropriate for this audience and if they perform in expected quantitative ways and psychometric patterns. A previous study of students indicated that instrument testing had been performed before use of the 10-item questionnaire; however, results of such testing were unclear, as this evaluation was a small element within a larger non-peer reviewed report with limited description of methods, results, and generalizability [55]. Explicit analyses of the FSSMs against psychometric benchmarks are needed and necessary to support the accuracy and

reliability of results. As a second concern, many studies compare their prevalence rates to those published nationally, such as from the Current Population Survey (CPS). Yet, these national procedures use a multi-step FI assessment protocol that includes screening after which many respondents are removed before FI is determined. At present, no prior studies have adopted this multi-step FI assessment protocol when estimating FI prevalence among post-secondary students. Given that the CPS estimates of national FI are the benchmark with which most studies compare their results, it is worthwhile to adopt the multi-step screening methodology and estimate FI prevalence among college students using methods similar to those in the CPS.

The purpose of this study was to address these gaps in the literature related to FI among post-secondary U.S. college students. The objective of the research was to assess the psychometric properties of the FSSM in a student sample and to evaluate the relative accuracy of different protocols (the 6- and 10-item USDA FSSMs, with or without screeners) in identifying high-risk students. It was hypothesized that: 1) the psychometric qualities of the FSSM would be lower than in national samples, and 2) utilizing the screener questions would result in the most relative accuracy when compared to other protocols. These hypotheses were tested in a cross-sectional sample of undergraduate students at a U.S. four-year university by assessment of data fit to the Rasch model and then comparison of each protocol and its performance in predicting students with FI.

Materials and Methods

Participants. A randomized sample of 1,000 students from each college classification (freshman, sophomore, junior, and senior; 4,000 students total) at one midwestern university was invited from the enrolled student registry to participate in an online survey hosted by the

Qualtrics, LLC (Provo, Utah, USA) survey platform. After reviewing a digital informed consent form, respondents consented to participate by selecting “I have read the procedure described above, and I voluntarily agree to participate in this survey.” All study procedures were approved by the institutional review board for research involving human subjects at the University of Illinois at Urbana-Champaign (#16008). Previous studies have reported sociodemographic differences between midwestern college students based on FI status [26], and race/ethnicity results were used as a basis for a chi-squared power analysis ($\alpha=0.05$, $\beta=0.9$) using G*Power (Version 3.1.9.2, Heinrich Heine University Düsseldorf). This revealed that a minimum of 134 individuals overall would be needed for bivariate analyses. Given the planned data analyses and projected response rate of online surveys, 1,000 students were sought per college classification to account for incomplete or unusable responses. The survey was administered beginning October 2017 (approximately 7 weeks into the fall 16-week semester) and two reminder emails were sent to eligible respondents, each one full week after the last. Participants who completed the survey were entered into a drawing for one of 250 \$10 digital gift cards. To be eligible, students needed to be: 1) between the ages of 18-24 years; 2) enrolled as an undergraduate student at the University of Illinois; and 3) fluent in English.

Survey. The online questionnaire was designed for completion within approximately 15 minutes on a mobile device or personal computer. Various participant sociodemographic characteristics were collected, including participant’s age, gender, college undergraduate class, race, country of birth, first-generation student status, and living situation. Financial resources were evaluated as a checklist with respondents indicating whether they received monetary support from their family/parent, employment, government/federal grants, scholarships, loans, and/or other sources. For those selected, participants were further asked to estimate the amount

they received from each source within a specified timeframe (week, month, semester, or year). An overall estimate of financial support was calculated by converting all values to a 1-semester interval and summing these values. To capture family socioeconomic background, respondents estimated their parent's income, perceived familial social class, and whether their family used the Supplemental Nutrition Assistance Program and/or free and reduced school lunches while the participant was enrolled in high school.

The surveying procedure was designed to emulate the screening protocol used in the CPS. However, the procedures were adapted for this survey of students. The 2-item screener used by the CPS (Table 3.1) was included and if a respondent answered 'No' and 'Enough of the kinds of foods that we want to eat', respectively, they were considered food secure. This screener in the CPS normally references the last twelve months, but a 30-day reference was used to only capture the on-campus experiences of students. In the CPS, high-income households who answer in a secure fashion are not asked the remaining food security questions. In the present study, the screener appeared before the 10-item USDA FSSM, but those who answered affirmatively to these items were not eliminated (i.e., screened out) from answering the FSSM. The impact of the screener was simulated during analyses by following the CPS procedures with additional modifications to the income threshold. Thus, the comparison between differing FI assessment protocols could be tested with a single sample. The screening procedure was first tested using no income estimates and this was followed with a second test where an estimate of 'financial adequacy' was developed to approximate an appropriate income threshold for students. To calculate financial adequacy the overall estimate of financial support per semester was compared with the cost of attendance for an average in-state resident at the University of Illinois [68,69] for the 2017 fall semester. While the survey instrument was designed to capture a variety of sources

of financial support, results revealed that students had a tendency to underreport their support level, as only 34.6% of students were considered to have adequate financial support. Given concerns that these financial support estimates and their accuracy were untenable, results from the assessment protocols integrating them with screening procedures are not presented here; however, these results are available upon request.

FI-related questions included the 2-item screener and the 10-item USDA FSSM with a reference period of the last 30 days. The 10-item USDA FSSM queried participants on their experiences with food and financial resources in a series of items that increased in severity. Items of these questionnaires and affirmative responses are included in Table 3.1. Individuals were considered FI if they responded affirmatively to three or more items or food secure otherwise. The abbreviated 6-item USDA FSSM is produced from a subset of the 10-item FSSM to reduce participant burden. Therefore, responses of a single sample of participants who answer all items on the 10-item FSSM can be used to simulate response patterns if only the 6-item FSSM was presented. Items used in the 6-item version are specified in Table 3.1. Given the reduced number of items, individuals were considered FI if they responded affirmatively to two or more items or food secure otherwise.

Data analyses. Before analyses, survey responses were excluded from the dataset if the respondent was ineligible for the study, the response was a duplicate of a prior response, or less than half of the 10-item USDA FSSM was complete. Once these responses were removed, the averages and distributions of responses on sociodemographic questions were calculated and compared to data (when available) from the entire university undergraduate student body. Descriptive analyses were conducted on all FI assessment protocols to illustrate differences in FI prevalence rates.

The psychometric properties of data were assessed by evaluating whether they fit the single-parameter Rasch measurement model, specifically to identify if items had similar calibrations and item severity order. Per the standardized questionnaire, items on the FSSMs were ordered from least to most severe, and in the general population, the quantity of affirmative responses to each item reflected this order. Similarity to projected response patterns [25] would indicate that the population manages and describes food deprivation similarly and would validate the comparison of rates ascertained among college students with national estimates. For this analysis, item severity parameters, item-infit statistics, and item-outfit statistics were assessed. Item severity parameters, and their ordering, were compared with data collected in the CPS [25]. The estimates of infit and outfit statistics, which reflect the discrimination and consistency of the item responses, respectively, provided further psychometric indicators of participant response patterns. A conservative range of 0.8 and 1.2 was used to evaluate the fit statistics produced by the 10-item FSSM [70] due to the range of distribution procedures in field settings and the use of FI prevalence studies to directly impact policy. This analysis was not conducted with participants who had missing values on some food security items or ‘extreme’ respondents (those who affirm either all or none of the items), per Rasch model protocol (Appendix C) [25, 71].

The agreement between four potential food security assessment protocols were compared: 1) the 6-item USDA FSSM without a screener; 2) the 10-item USDA FSSM without a screener; 3) the 6-item USDA FSSM with a 2-item screener; and 4) the 10-item USDA FSSM with a 2-item screener. Agreement was calculated for each comparison by taking the difference of the FI designation (yes=1, no=0) produced from two protocols. These agreement values were expressed as percentages with 95% confidence intervals based on the standard deviation of the difference.

The relative accuracy of the assessment protocols in identifying participants with FI was assessed by testing each protocol's designation of the individual (food insecure=1, food secure=0) as the dependent variable in logistic regression models and comparing the relative fit of each model. Multivariate logistic regression models were constructed to predict the odds of a student being considered FI based upon risk factors that have been identified as impactful in previous literature [17,20,30,35,41-43,46,51,56]. After testing for potential collinearity, these variables included: race/ethnicity, college classification (Freshman, Sophomore, etc.), social support (living with others), transfer student status (prior enrollment in a community college), first-generation college student status, familial socioeconomic status (comprised of perceived familial social class and use of federal nutrition assistance programs during high school), and sources of financial support [including family, employment, government, scholarship(s), and loan(s)].

To analyze the fit of data to the Rasch model, the 'ERSRasch' protocols for SAS 9.4 (SAS Institute Inc, Cary, North Carolina, U.S.) provided by the U.S. Economic Research Service were used. All other statistical analyses were performed in STATA/MP 14.1 (StataCorp, LP, College Station, Texas, U.S.). The complete de-identified dataset as well as the corresponding codebook and statistical analysis files are available as supplementary materials.

Results

A total of 633 responses were received for the online survey. Of these, 44 respondents did not consent to participate, 22 individuals did not meet inclusion criteria, 80 completed less than half of the 10-item FSSM, and 25 completed the survey twice (the second response or incomplete responses were removed), resulting in a final response rate of 11.5% and sample of

462 participants. Sociodemographic characteristics of participants and comparisons with the institution's undergraduate student body are reported in Table 3.2.

Participating students were, on average, aged 19.6 years and roughly balanced across undergraduate college classifications. The majority was born in the U.S., identified as female, and White or Asian/Pacific Islander. Financially, most students received support from their families. The vast majority estimated their familial social class was middle class, though 21% (n=96) did not estimate their parents' income. A minority of students indicated limited socioeconomic resources, with a few identifying as families of lower social class or reporting that their families used federal nutrition assistance programs (i.e., free or reduced National School Lunch Program and the Supplemental Nutrition Assistance Program). A minority of respondents indicated that they were first-generation students. In comparison to the entire student body, the recruited sample was younger, less likely to be a college senior, more likely to identify as White or Asian/Pacific Islander and female.

Results when analyzing the 10-item FSSM using the Rasch model are presented in Table 3.3. This procedure reflects the way that the survey is often used in the field and provides indications of responses on all 10 items. Affirmations of FSSM items ranged from 4.1% on the most severe item, which asked about number of days in which no food was consumed, to 64.5% on the third item that asked if students can afford a balanced meal. Item difficulty estimates reflected these affirmations in quantifiable severity estimates, showing that the final item on the 10-item AFSSM was the most difficult and the balanced meal item was considered the least difficult. The expected response pattern was for items to flow from least to most difficult, and results in this sample deviated from this pattern. The first four items of the survey showed particular deviation, with the 'balanced meals' item accruing 5% more affirmative responses

than item one, which was expected to be the most commonly affirmed. For infit and outfit statistics, there were deviations outside of the acceptable range of 0.8 – 1.2 for seven of the ten items evaluated. These non-conforming infit and outfit statistics indicate that there was inconsistency in response patterns and potentially high discriminating value in single items.

When estimating FI (low and very low levels), Figure 3.1 reflects how prevalence differs by protocol used. The greatest prevalence of FI was estimated by the 6-item FSSM without screening, and the lowest prevalence was ascertained from the 10-item questionnaire when used with the 2-item screener. Prevalence rates when using the 2-item screener were lower because 327 students (70.8%) answered the screener questions in food secure patterns and thus would not be administered the FSSM under the CPS protocol.

Agreement between FI protocols is displayed in Table 3.4. Overall, each protocol had strong levels of agreement, but there was variation across protocols. The greatest agreement levels (>95% agreement) were seen when comparing the length of questionnaires (6- or 10-item) with consistent screening protocols. Agreement was diminished when comparing protocols across screening regimes, with percent agreement as low as 84%.

Multivariate logistic regression models were built for each FI estimation protocol. Due to missing data, regression analyses were run on a sub-sample of respondents (n=427). The multivariate regression models are presented in Table 3.5. Sources of financial support had a significant impact on predicting FI status. Across all FI protocols, familial financial support significantly predicted lower odds for being FI, while loans significantly predicted higher odds for being FI. Financial support from employment also increased the odds for being FI in two of the four models. Outside of sources of financial support, a higher college classification (sophomore, junior or senior status) significantly increased the odds of being FI in the majority

of models when compared to freshman students. Higher perceived social class also decreased odds for FI, but only in the models predicting FI based on protocols that incorporated the screener. The protocol using the 10-item FSSM and the 2-item screener had the overall best model fit based on McFadden's R^2 (0.15) and the Bayesian Information Criterion (-2049.72).

Discussion

The aim of this study was to evaluate the standard food security assessment protocols when used among undergraduate college students. Specifically, cross-sectional data from 462 students were used to assess the psychometric properties of the overall survey and then compare the agreement and relative accuracy of four FI estimation procedures. Data supported both proposed hypotheses. First, student responses on the USDA FSSM did not follow the expected difficulty pattern and fit statistics indicated some potential issues on the item-level. Then, when protocols were compared, agreement was generally high. However, agreement was lowest for the FSSMs when paired with the 2-item screener, which resulted in the two lowest FI estimates among students. Finally, this lowest prevalence of FI was supported as the most relatively accurate when predicted by student sociodemographic characteristics.

Results of the Rasch model analysis indicated that the performance of the 10-item FSSM was less than ideal in this college student sample. Affirmative response patterns deviated from the expected flow from least to most severe and the corresponding proportion of affirmative responses. The item that asked students if they could afford a balanced meal was affirmed the most frequently. This keyword 'balanced meals' has been scrutinized previously when the FSSMs were evaluated for use in Asian and Pacific Islander populations [64-66]. This item, as well as others, may have keywords that elicit different cognitive responses than expected, based

on the formative work used to construct the questions that ultimately resulted in the USDA FSSMs [60,72].

Beyond the deviated order of item difficulty, the Rasch model analyses also revealed that item fit statistics were outside of customary ranges for several items. These statistics reflect ‘noisy’ response patterns, which can result as a product of careless responses due to survey fatigue or limited discriminating power of the questions. The potential fatigue of respondents in this study is less likely given that the FSSM items were placed at the beginning of the online survey, which in and of itself was structured to take less than 15 minutes. Alternatively, limited item discrimination power may be a result of heterogenous responses that participants had to the financial qualifying aspect of each item. When a general adult audience responds to the questionnaire, many would equate an inability to ‘afford’ or have ‘enough money’ for food with the presence and/or adequacy of regular paychecks resulting from employment. In contrast, post-secondary students have a variety of financial situations. An increasing number of college students are employed while enrolled in school [73], but this is one source of support within a larger assortment of resources, both formal or informal, that students may have access to and utilize to ascertain food. The need to consider and calculate these various food and financial support sources while answering seemingly straightforward questions may result in participants ‘satisficing’ and providing a less accurate but convenient response [74]. Given the heterogeneity of support situations, this may explain the erratic response patterns on the survey. However, qualitative studies utilizing cognitive interviewing techniques would be needed to accurately illustrate how students process the FSSMs and used to support modifications to the FSSMs for this population.

Until adapted FSSMs are proposed and tested, researchers in the field will need to consider which current FI assessment protocol is appropriate for their sub-population. Findings from the current study comparing protocols provide clear indications that different methods impact FI prevalence estimates, with estimates ranging from 19.1% to 34.9% in a single sample. The protocols tested are a subset of those used previously in the field, and the various agreement levels between methods may, in part, explain the wide range of prevalence estimates previously reported across studies [1,2]. When the 2-item screener was implemented, FI prevalence rates in the sample were reduced by approximately one-third.

Using the 10-item FSSM with the 2-item screener had the greatest ability to identify FI students based on established predictor variables. Though all models had limited predictive power, this protocol may provide the most relative accuracy when estimating FI prevalence as well as evaluating the impact of interventions taking place across campuses nationally [57,75]. Furthermore, this protocol more closely resembles those used in the CPS and will allow for more straightforward comparisons of rates of FI among students with those at the national level. However, efforts to simulate the CPS screening that included financial adequacy estimates were unsuccessful in this study. Issues with measurement of financial support in this sample are indicated by the estimate that only 34.6% were considered to have adequate financial support.

Evaluating financial resources among students is inherently complex and is reflected in the methods used to evaluate financial support in the current study. Though efforts were made to create a comprehensive assessment of 'income' among students, the estimate showed low predictive power of FI and was ultimately not presented in the current article. Though FI is not synonymous with low-income status, and other factors have mitigating impacts on FI risk [76,77], there is commonly a strong relationship in the general population. Parental income could

be used as a proxy for student income, as it is used to calculate the Expected Family Contribution when calculating financial aid offers [78], but this has issues in practice. Specifically, there is the concern that parental income and calculated expected contributions do not resemble actual contributions to students. More practically, many students in the current study selected ‘don’t know’ when asked about their parent’s income, making it difficult to accurately assess. In contrast, asking about the presence of familial financial support may be a valuable proxy as it was a significant protector against FI among students in this population and respondents could more readily provide responses to the discrete question.

The current study provides indications for relative accuracy of differing FI assessment protocols among college students. At its core, accuracy attempts to evaluate whether tests result in an unbiased correct answer. However, it is difficult to evaluate whether a FI assessment protocol is identifying “true” FI, as this is an inherently subjective social condition. In other populations, these accuracy analyses have been conducted by evaluating how different protocols correlated with indicators of food insufficiency, such as use of a food pantry as a coping mechanism [79,80]. However, some of these coping behaviors are not as common for young adults, even when considered to have very low food security [15]. Other researchers have attempted to assess ‘definitive classifications’ of FI to develop criterion validity [81,82], but this is labor-intensive and often requires subjective assessments from observers. In contrast, the current study compares how differing assessment protocols identify individuals as FI and which protocol is best predicted by student characteristics that are theorized. This method of using determinants and consequences of FI has been conducted in other populations but provides the strongest indication of FI protocol accuracy when interpreted as part of a larger body of literature (as was done for the larger U.S. population in previous work) [58].

Considerations of FI assessment accuracy are important not only for researchers in the field, but also for universities interested in supporting increasingly diverse student populations. Many universities are enacting policies and interventions to address FI among their students [83]. Given the limited resources, both in terms of time and finances, available to many universities, it is vital that students with the greatest need are accurately identified. It is important that universities carefully consider which questionnaire they use not only for screening students but also for evaluating the effectiveness of any programs (such as campus food pantries or free dining hall meals) in alleviating FI. Though the 6- and 10-item USDA FSSMs have been commonly used in the past because they take little time to complete, minimize participant burden, and are simple to score, the current results suggest that included a 2-item screener may be valuable for assessing FI among post-secondary students in the field.

This research should be interpreted with considerations to the limitations of the study design and methodological choices. First, the online survey received a limited response rate. The study sample is comprised of those who decided to participate, which introduces selection bias. However, the sociodemographic characteristics of the sample had several similarities to the larger undergraduate student body. The largest difference between the sample and sampling pool was the greater proportion of female student participants, but women often respond at greater rates to surveys [84]. If questionnaires were administered in-person, a larger number of responses may have been collected. However, this methodology is much more time-intensive and still can pose its own issues with ascertaining a truly random sample. For example, prior FI assessment studies in college settings have recruited participants by selecting a list of courses [41,42], but this assumes all enrollees are in attendance. Ultimately, the recruitment efforts for this study resulted in a sample size that met power analysis needs. Aside from response rates, the

study design attempted to identify an accurate measure of food security, but this is a subjective experience and thus is limited based on how accuracy is evaluated. Evaluations of these protocols in tandem with qualitative interviews and triangulation with other student risk factors and coping behaviors would provide further evidence for accuracy of assessment protocols. Further, generalizability of current results is limited by the single midwestern University sample. Therefore, this psychometric evaluation can, and should, be re-evaluated utilizing samples that include students from universities in various geographical and socio-economic settings. The limited population included in the current sample inhibits generalizability, but the more homogeneity of the sample increases the internal validity of the results and overall statistical power to speak to traditional aged undergraduate students at a Midwest university in the U.S.

Conclusions

Results from the current study indicate that the psychometric properties of FSSMs when used in college students were not ideal. These results warrant additional qualitative investigations of the FSSMs and possible adaptations for FI assessments in the college student population. Until these survey modifications are made, results of this protocol comparison analysis provide evidence that the way that FI is estimated among college students makes a substantial difference in reported prevalence, particularly with use of screeners. Given the limited resources available for universities to identify and serve students living with FI, it is vital that the way FI is assessed will accurately identify students most critically in need, such that the true impact of interventions may be evaluated. Current results suggest that the 10-item FSSM used along with the 2-item screener is the best currently available measure; however, replicating these analyses with a larger and more diverse sample is warranted.

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Table 3.1. Food security questionnaire items and coding of response options as insecure or secure.

<i>Item</i>	<i>Affirmative (Insecure) Response(s)</i>	<i>Negative (Secure) Response(s)</i>
2-item Food Sufficiency Screener:		
In the last 30 days, did you ever run short of money and try to make your food or your food money go further?	Yes	No
HH1. Which of these statements best describes the food eaten in your household?	Enough but not always the kinds of food we want to eat, Sometimes not enough to eat, Often not enough to eat	Enough of the kinds of food we want to eat
10-item Food Security Survey Module:		
HH2. I worried whether my food would run out before I got money to buy more.	Often true, Sometimes true	Never true, Don't know
HH3. The food that I bought just didn't last, and I didn't have enough money to get more.*	Often true, Sometimes true	Never true, Don't know
HH4. I couldn't afford to eat balanced meals.*	Often true, Sometimes true	Never true, Don't know
AD1. In the last 30 days, did you ever cut the size of your meals or skip meals because there wasn't enough money for food?*	Yes	No, Don't know
AD1a. In the last 30 days, how many days did this happen?*	≥3 days	1-2 days
AD2. In the last 30 days, did you ever eat less than you felt you should because there wasn't enough money for food?*	Yes	No, Don't know
AD3. In the last 30 days, were you ever hungry but didn't eat because there wasn't enough money for food?*	Yes	No, Don't know
AD4. In the last 30 days, did you lose weight because there wasn't enough money for food?	Yes	No, Don't know
AD5. In the last 30 days, did you ever not eat for a whole day because there wasn't enough money for food?	Yes	No, Don't know
AD5a. In the last 30 days, how many days did this happen?	≥3 days	1-2 days

Source: Bickel, G., Nord, M., Price, C., Hamilton, W., & Cook, J. (2000). *Guide to measuring household food security*. Retrieved from <https://www.fns.usda.gov/guide-measuring-household-food-security-revised>

* Items used in 6-item Food Security Survey Module

Table 3.2. Sociodemographic characteristics of random sample of undergraduate students who participated in an online survey and comparison with university’s undergraduate student body.

Characteristic^a	All Participants^b (n=462)	Undergraduate Student Body^{b,c} (n=33624)
<i>Age (years), mean ± SD</i>	19.6 ± 1.3	20.5 ± NR
<i>College Classification, % (n)</i>		
Freshman	27.3% (126)	20.3% (6837)
Sophomore	22.5% (104)	22.9% (7701)
Junior	28.1% (130)	24.7% (8287)
Senior	22.1% (102)	29.9% (10051)
<i>Race/Ethnicity, % (n)</i>		
White	51.4% (233)	44.8% (15061)
Black/African American	5.3% (24)	5.9% (1973)
Hispanic or Latino/a	9.7% (44)	11.2% (3748)
Asian/Pacific Islander	27.2% (123)	18.0% (6053)
Other/Mixed	6.4% (29)	20.2% (6789)
<i>Gender, % (n)</i>		
Male	35.6% (162)	54.6% (18345)
Female	63.7% (290)	45.4% (15267)
Other	0.7% (3)	0.0% (12)
<i>Living Situation, % (n)</i>		NR
Lives alone	10.4% (47)	
Lives with other(s)	89.7% (407)	
<i>Birth Country, % (n)</i>		
United States	83.1% (378)	83.4% (28028)
Other country	16.9% (77)	16.6% (5569)
<i>First-Generation Student, % (n)</i>	24.3% (107)	20.0% (NR)
<i>Sources of Financial Support,^d % (n)</i>		NR
Family	85.1% (382)	
Employment	50.3% (226)	
Government	35.4% (159)	
Scholarship	47.4% (213)	
Loans	38.5% (173)	
Other	1.8% (8)	
<i>Estimated Parental Income, % (n)</i>		NR
Under \$15000	2.7% (12)	
\$15000 to \$34999	8.5% (38)	
\$35000 to \$54999	9.8% (44)	
\$55000 to \$74999	12.5% (56)	
\$75000 to \$99999	11.8% (53)	
\$100000 to \$149999	17.8% (80)	
\$150000 or more	18.5% (83)	
Don't know	18.5% (83)	
<i>Perceived Familial Social Class, % (n)</i>		NR
Lower class	9.4% (42)	
Middle class	79.2% (355)	
Upper class	11.4% (51)	
<i>Familial NSLP use, % (n)</i>	19.3% (86)	NR
<i>Familial SNAP use, % (n)</i>	5.2% (23)	NR

NR=Not Reported, NSLP=National School Lunch Program, SNAP=Supplemental Nutrition Assistance Program; ^a Missing data: race/ethnicity (n=9), gender (n=7), living situation, (n=8), birth country, (n=7), first-generation student (n=22), sources of financial support (n=13), estimated parental income (n=13), perceived familial social class (n=14), familial NSLP use (n=17), and familial SNAP use (n=16); ^b Sum of column may not add to 100% due to rounding; ^c Division of Management Information publicly available student enrollment data; ^d Sum of column will be greater than 100% as participants could select more than one source

Table 3.3. Item response statistics for 10-item Adult Food Security Survey Module among a random sample of undergraduate students who participated in an online survey (n=217^a).

Item	Affirmative responses, n	Affirmative responses, %	Difficulty, estimate (SE)	Item infit, estimate	Item outfit, estimate
Worried run out of food	129	59.4%	5.45 (0.17)	1.22	1.06
Food bought didn't last	89	41.0%	6.52 (0.18)	1.23	1.23
Cannot afford balanced meal	140	64.5%	5.18 (0.17)	1.30	1.18
Cut or skip meals	125	57.6%	5.56 (0.17)	0.67	0.54
Cut or skip meals, ≥ 3 days	97	44.7%	6.29 (0.18)	0.63	0.47
Eat less than should	100	46.1%	6.21 (0.18)	0.85	0.78
Hungry, did not eat	79	36.4%	6.80 (0.18)	1.00	0.94
Lost weight	27	12.4%	8.69 (0.24)	1.30	1.46
Did not eat whole day	17	7.8%	9.28 (0.29)	0.95	0.88
Did not eat whole day, ≥ 3 days	9	4.1%	10.01 (0.37)	0.95	0.63
Mean			7.00		
Standard Deviation			1.62		
Discrimination Parameter			1.00		

Difficulty, item infit, and item outfit are results from a Conditional Maximum Likelihood Rasch model using unweighted data. Fit statistics have an expected ideal value of 1 with a range of 0 to infinity. In this study, the estimates were compared to a preferred range of 0.8 to 1.2. High infit values indicate a weak association of the item to the underlying trait and high outfit estimates indicate inconsistent responses to the item when compared with the overall scale. Low infit and outfit estimates generally reflect high discrimination or Guttman response patterns where the item reflects a rapid transition from mostly affirmative responses to almost none.

^a The sample for this analysis only includes responses with complete data (no missing data) and for individuals who affirmed 1 to 9 items on the survey (non-extreme responses)

Table 3.4. Agreement of assessment protocols predicting food insecurity (FI) among undergraduate college students (n=462).

Protocol	Protocol			
	6-item	10-item	6-item + screener	10-item + screener
	%			
	(95% CI)			
6-item	-			
10-item	96.3 (94.2, 97.8)	-		
6-item + screener	85.1 (81.5, 88.2)	86.1 (82.7, 89.2)	-	
10-item + screener	84.2 (80.5, 87.4)	87.0 (83.6, 89.9)	99.1 (97.8, 99.8)	-

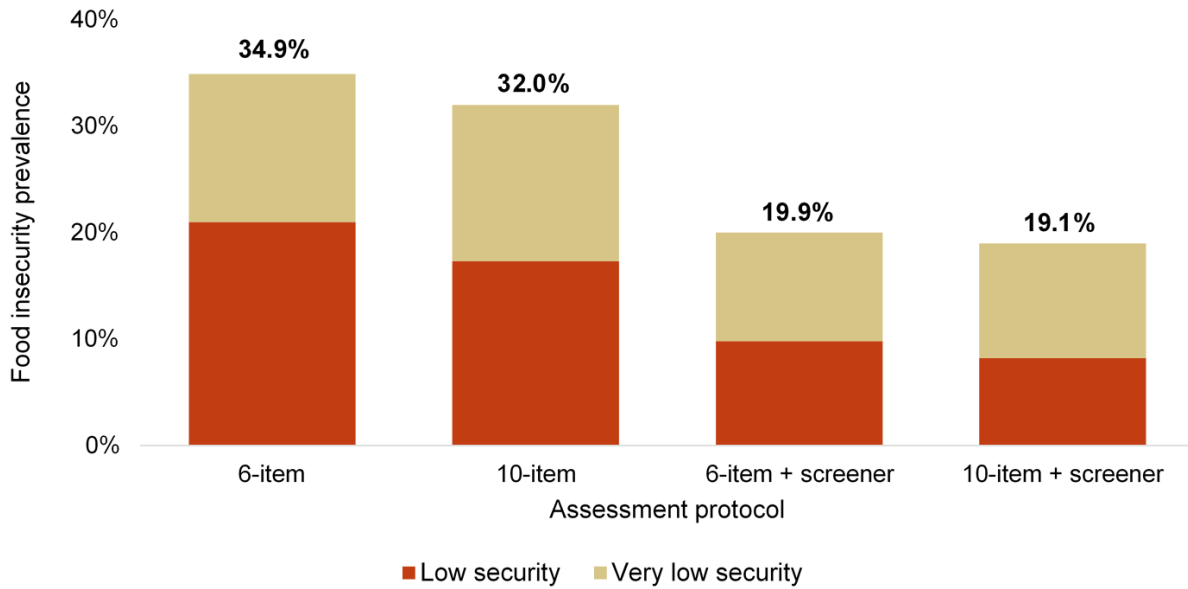
Agreement for each comparison was based on the difference of the FI designation (yes=1, no=0) produced. The mean is expressed as the percentage; the 95% CI is based on the standard deviation.

Table 3.5. Comparison of assessment protocols predicting food insecurity (FI) among undergraduate college students based on theoretical predictors in logistic regression models (n=427).

Variable	Predicting FI with 6-item survey		Predicting FI with 10-item survey		Predicting FI with 6-item survey + screener		Predicting FI with 10-item survey + screener	
	Odds Ratio	Standard Error	Odds Ratio	Standard Error	Odds Ratio	Standard Error	Odds Ratio	Standard Error
Intercept	0.48	0.36	0.64	0.48	0.63	0.54	0.76	0.66
<i>Race^a</i>								
Asian	0.91	0.25	1.06	0.30	0.84	0.29	0.92	0.33
Other	0.88	0.28	0.91	0.29	0.92	0.33	1.05	0.39
<i>Classification^b</i>								
Sophomore	1.83 [†]	0.59	1.72	0.58	3.18**	1.39	3.09*	1.42
Junior	2.15*	0.68	2.53**	0.82	4.14**	1.79	4.61**	2.07
Senior	1.37	0.46	1.45	0.51	2.76*	1.24	2.81*	1.31
<i>Living Situation^c</i>								
Live with other	1.27	0.47	1.08	0.40	0.84	0.35	0.77	0.32
<i>Transfer Student</i>	1.04	0.40	1.04	0.40	0.77	0.34	0.79	0.36
<i>First-Generation Student</i>	1.18	0.34	1.24	0.36	0.97	0.32	0.98	0.34
<i>Perceived Social Class^d</i>								
Middle class	0.71	0.32	0.56	0.26	0.35*	0.17	0.28*	0.14
Upper class	0.80	0.46	0.58	0.34	0.18*	0.12	0.16*	0.11
<i>NSLP in High School</i>	1.84 [†]	0.67	1.84 [†]	0.68	1.40	0.59	1.34	0.58
<i>SNAP use by Family</i>	2.22	1.35	1.33	0.78	1.81	1.07	1.32	0.79
<i>Financial Support: Family^e</i>	0.46*	0.15	0.38**	0.12	0.37**	0.13	0.32**	0.11
<i>Financial Support: Employment</i>	1.59 [†]	0.38	1.65*	0.40	1.46	0.42	1.63 [†]	0.48
<i>Financial Support: Government</i>	0.85	0.26	0.75	0.23	0.97	0.35	0.96	0.36
<i>Financial Support: Scholarship(s)</i>	0.58*	0.15	0.60 [†]	0.16	0.43**	0.14	0.40**	0.13
<i>Financial Support: Loan(s)</i>	2.19**	0.56	2.20**	0.58	1.65	0.50	1.75 [†]	0.54
<i>Measures of Fit</i>								
McFadden's R ²	0.10		0.11		0.13		0.15	
BIC	-1907.53		-1925.39		-2033.40		-2049.72	

NSLP=free or reduced-price National School Lunch Program; SNAP=Supplemental Nutrition Assistance Program; BIC=Bayesian Information Criterion; [†]P<0.10 * P<0.05, ** P<0.01; ^a Relative to White; ^b Relative to Freshman classification; ^c Relative to Living Alone; ^d Relative to Lower Class; ^e Relative to not having financial support from each source

Figure 3.1. Prevalence rates of food insecurity among undergraduate college students by assessment protocol (n=462).



Note. Assessment procedures and scoring protocols being compared are the: 1) Six-Item Short Form of the USDA Food Security Survey Module; 2) 10-item USDA Adult Food Security Survey Module; 3) Six-Item Short Form with two screening items used in the Current Population Survey; and 4) 10-item USDA Adult Module with two screening items used in the Current Population Survey.

CHAPTER 4: ESTIMATING FOOD INSECURITY AMONG COLLEGE STUDENTS: COMPARISON OF SURVEYING MEDIUMS³

Abstract

Background. Food insecurity (FI) continues to be an important issue in the United States. A growing body of literature suggests that college (i.e., post-secondary) students experience FI at alarming rates. However, the commonly used FI questionnaires have undergone limited evaluations for accuracy in this sub-population.

Objective. This exploratory test-retest study aims to evaluate if FI estimates among college students differ by survey distribution modality, specifically paper-and-pencil versus online questionnaires.

Design. A random sample of undergraduate students (n=343), aged 18 to 24 years, participated in an online survey and agreed to be contacted for future studies. FI was assessed with the 2-item food sufficiency screener and the 10-item Adult Food Security Survey Module. After completing the online survey, a random sample of these students (n=66; 29%) completed the same items in paper-and-pencil format.

Participants/setting. Participants were aged 19.5 (\pm 1.2) years and were predominantly female (71%). Undergraduate university students completed online questionnaires at a location of choice and paper-and-pencil questionnaires in a survey research laboratory.

Main outcome measures. Responses to each survey item and FI classification of students based on each modality were compared.

³ Currently under review for publication in the *Journal of the Academy of Nutrition and Dietetics*

Statistical analyses performed. Reliability across modalities was assessed with percent agreement and kappa (κ) coefficients.

Results. Students were less likely to affirm each item on paper-and-pencil questionnaires. Percent agreement ranged from 71.2-96.9% across items, and κ coefficients ranged from poor to fair. FI prevalence differed by 15% between online and paper-and-pencil assessments (40.9% and 25.8%, respectively). Percent agreement for FI categorization was 75.8% and $\kappa=0.47$.

Conclusions. Differing survey modalities used with the same study participants resulted in varying FI classifications among a sample of undergraduate students. Though limited by size and representativeness, the study supports the need for further psychometric testing of FI surveys, as accurate FI estimates are essential to serving college students.

Introduction

College (i.e., post-secondary) students in the U.S. experience food insecurity (FI) at an estimated rate of 38%.¹ FI is generally defined as a shortcoming in access to enough food for an active, healthy life.² In the general population, FI is related to mental health,³ dietary quality,⁴ and chronic diseases.^{5,6} Specifically, students experiencing FI are at greater odds of having low quality dietary patterns and physical health, as well as impaired academic success.⁷ This evidence has stimulated federal investigations into FI issues among college students, resulting in policy recommendations to better support students in need.⁸

Efforts to serve students experiencing FI are stymied by recent studies indicating that current surveying methods may have shortcomings and could be misclassifying students. A recent meta-analysis in the field found that FI prevalence estimates were dramatically influenced by the type of survey used.¹ A psychometric investigation using an online survey of

undergraduate students has also revealed that response patterns do not conform to expectations.⁹ The protocol using a 2-item food sufficiency screener alongside the U. S. Department of Agriculture's (USDA) Adult Food Security Survey Module (FSSM) – a protocol not commonly adopted in this field – had the strongest predictive power when compared with other surveying protocols.⁹ These concerns about the appropriateness of FI survey protocols were further supported by a recent qualitative investigation that revealed that college students had a number of unique interpretations of items and keywords used in the FSSM.¹⁰ Altogether, these findings provide mounting evidence that the FSSMs may be misclassifying college students. However, one unexplored facet in these investigations has been the reliability of questionnaires in different surveying formats, specifically online versus paper-and-pencil administration. A recent meta-analysis revealed that a wide variety of surveying modalities have been used in the field, with online distribution the most commonly applied format.¹

With the increasing digitization of modern society, use of online surveys to conduct research has become ubiquitous across various fields. Collecting data with online surveys has several advantages, including lower costs, efficiency of data entry, automatic scoring, and anonymity of participants.^{11,12} However, comparing the reliability of surveys using these distribution modalities is important. Many psychometric studies have been undertaken to ensure that there is data equivalency – the underlying responses patterns and overall results are approximately the same – between surveys using differing formats. Issues have arisen for some surveys when distributing them online.¹³⁻¹⁵ However, other surveys receive approximately the same responses when distributed online.^{12,16,17} There is a large amount of evidence that many surveys can be acceptably distributed in various modes.^{18,19} Despite this, establishing evidence

for surveys commonly distributed using one mode or when surveys are used for specific populations is critical.^{16,20}

The current study aims to evaluate if FI estimates among college students differ by survey distribution modalities, specifically online distribution versus paper-and-pencil questionnaires. Given the impact of modalities on other sensitive surveying topics,^{13,16} it was hypothesized that responses to a common questionnaire using these two mediums would differ.

Materials and Methods

Study Design. This exploratory repeated measures (i.e., test-retest) study compared responses of undergraduate students when they answered FI questions in an online survey and then the same items in a paper-and-pencil questionnaire. Data were collected from students between October and December, 2017. Before the online survey, respondents reviewed a digital informed consent form and consented to participate by selecting “I have read the procedure described above, and I voluntarily agree to participate in this survey.” Of the students who completed the initial online questionnaire and agreed to be contacted for future studies, a random subset was invited to participate in the paper-and-pencil follow-up study within one month of the online study. When participants arrived for the paper-and-pencil study, they reviewed and signed a printed informed consent form. All study procedures were approved by the institutional review board for research involving human subjects at the University of Illinois at Urbana-Champaign (protocols #16008 and #18224).

Participants. Study participants were recruited by sending an email invitation to a random sample of 4,000 undergraduate students at one land-grant university in the Midwest of the U.S. Eligibility criteria included enrollment as an undergraduate student, being aged 18-24

years, and self-assessment of fluency in English. Additional details about the recruitment and power analysis are described elsewhere.⁹ The sampling frame for the present study was among students who completed the online surveying study and had agreed to be contacted for future research (n=343). The sample was categorized as food insecure or secure, based on protocols detailed below. An equal number of participants in each categorization (112 secure and 112 insecure) were randomly invited to participate in the paper-and-pencil phase.

Questionnaire. FI was assessed with a 2-item food sufficiency screener and the 10-item USDA Adult FSSM. The 2-item screener emulates the screening procedure used in the Current Population Survey by categorizing respondents as secure if they indicate they are not running short of money and eating enough of the kinds of foods they would like to eat.²¹ If either of the two items in the screener are responded to in an insecure pattern, the participant's responses to the 10-item USDA FSSM are used to identify their FI status. The FSSM asks about the individual's experiences with food and available financial resources regarding issues of increasing severity.²² Each FI question was scored as food insecure or food secure based on established protocols.^{21,22} If three or more items are responded to in a food insecure pattern, the participant is considered food insecure. Additional questionnaire items collected information on each participant's age, undergraduate classification, race, gender, birth country, first-generation student status, financial support sources, and estimated parental income. These items were used to describe the general characteristics of the sample.

Analyses. The percentage of affirmative (i.e., food insecure) responses to each item and the percentage of students categorized as food insecure were calculated for each survey distribution modality. Agreement between the modalities on each item and their overall categorization was assessed with percent agreement, kappa coefficients, and Spearman

correlation coefficients. Kappa coefficients test agreement between modalities, while controlling for chance agreement, and criteria outlined by Landis and Koch were used.²³ Reliability is categorized as poor ($\kappa < 0.4$), fair (κ between 0.40-0.58), good (κ between 0.59-0.74), or excellent ($\kappa > 0.74$). As an alternative, to allow for comparisons with prior studies that do not use κ coefficients, Spearman correlation coefficients (ρ) that evaluate the general association of scores were calculated, but these should be interpreted with caution as they do not adjust for chance agreement.

Results

A total of 66 students (response rate=29%) participated in both the online and paper-and-pencil phases. Characteristics of the sample are shown in Table 4.1. Students were on average aged 19.5 (± 1.2) years, and a greater proportion were female (71%). Compared with the general undergraduate student body in the 2017 fall semester,²⁴ participants were more likely to be Freshman or Sophomore students, more likely to identify as white or Asian, and more likely to identify as female.

Comparisons of the online and paper-and-pencil survey distribution modalities are shown in Table 4.2. Students less frequently affirmed each of the questionnaire items when answering the paper-and-pencil questionnaire. This resulted in a 25.8% FI prevalence estimate from the paper-and-pencil survey in comparison with an estimated rate of 40.9% FI from the online survey. Percent agreement was greater than 70% for each questionnaire item, but kappa coefficients revealed poor to fair reliability across the modes. Though often seen as a more liberal agreement estimate, Spearman's correlation coefficients revealed similar issues and all questionnaire items had correlations below 0.6. The overall FI classification between the survey

modalities had a 76% agreement and the kappa and Spearman's coefficients indicated the agreement could be considered fair (0.4-0.58).

Discussion

The aim of the current study was to evaluate if there were any differences in responses to FI questions or in the FI prevalence estimates produced from college students when surveyed online or with a paper-and-pencil questionnaire. It was hypothesized that responses would differ between these two modalities, and the results of the reliability analyses support this hypothesis. Across all items on the questionnaire, when students answered items on a paper-and-pencil questionnaire they were less likely to respond affirmatively. Overall, the alterations in response patterns led to 15% difference in FI prevalence produced by the two survey modalities.

FI among college students is clearly a prominent issue in the U.S. and efforts to alleviate or prevent FI are imperative.⁸ However, to ensure that screening programs and policies or initiatives to serve students experiencing FI are effective, surveying protocols need to be valid and reliable. The current results indicate that surveying modality can produce varying responses to FI questions, but it is unclear which one of the modes produces the accurate FI estimate. It is possible that responses on the paper-and-pencil survey may be lower due to social desirability and lack of perceived anonymity.¹⁶ Alternatively, students may be more focused on paper-and-pencil surveys because there is lower distractions than would be present when responding to online surveys on personal computers or mobile devices. Unlike in dietary survey validation studies, which can incorporate recovery markers or other objective measures of dietary quality,²⁵ there is no confirmatory diagnostic assessment of individual FI.

The current results add to the growing body of evidence suggesting that there are psychometric shortcomings of the FSSMs for the U.S. college student population.^{1,9,10} Though the 10-item FSSM with the 2-item food sufficiency screener is supported for use with college students,⁹ which is the protocol used in the current study, there is no broad consensus on the most accurate protocol and distribution method. Currently, the 6-item FSSM is the most commonly used and surveys are often distributed online.¹ Additional psychometric testing of the surveys to develop widespread guidelines would be valuable. Until broader guidelines are available, individuals using these surveys for research and in the field to serve students experiencing FI will need to weigh the evidence against their priorities and goals. Those with limited financial support or interested in identifying students with the greatest need may find the best option for their project is the 10-item FSSM with the 2-item screener distributed using paper-and-pencil forms. Others interested in identifying students with any possible FI issues (i.e. low specificity and high sensitivity) with ample financial support may find the 6-item FSSM distributed online is appropriate for their needs. Regardless of survey modality, many students are reporting experiences of FI and it is clear that existing, and future, efforts to serve them are needed.

Limitations and Future Directions. The current study is not without limitations. All respondents answered the online survey before answering the paper-and-pencil survey, so the order of survey modality may have influenced the results. However, results are consistent with the influence that social-desirability has when other surveys are distributed using paper-and-pencil questionnaires.¹⁶ The current study is also limited by the small sample size and that all respondents were undergraduate students between 18-24 years old attending a single four-year land-grant university. Though this limits the generalizability of results to the larger college

student population, the homogeneity of the sample allows for limited variability and influence of sociodemographic and environmental factors on the statistical tests. Future studies investigating the psychometrics of the FI questions can address the limitations of the current study. Testing modality, test-retest reliability, or the impact of various surveying protocols should be handled with crossover designs to control for the potential influence of order. In addition, comparing psychometric investigations across various student populations (i.e., first-generation, graduate-level, non-traditionally aged students) and across various institution types (i.e., private institutions, community colleges, trade schools) will be critical to understand if FI questions are valid and reliable across the general student population and if identified issues are not unique to the population included in this study.

Conclusions

The results of the current study reveal that survey responses and FI estimates among college students are impacted by the distribution modality (i.e., paper-and-pencil, online). It is paramount that college FI research be conducted with reliable and valid instruments that have been psychometrically-tested in this population. Further psychometric testing, using both quantitative and qualitative methods, will be essential to confirm accurate surveying methods for the college population. This is not only vital to ensure that screening efforts are accurate and alleviation efforts are appropriately evaluated, particularly in that most work is conducted under constraints of limited funding. More important is the availability of strong empirical evidence on student FI to use to influence political will to ensure that additional funding is allocated to support students making dire personal sacrifices to attain an education that is increasingly perceived as mandatory for employment in the current economy.²⁶ Practitioners using these

surveys to assess student FI will need to carefully consider the evidence for differing survey protocols against the priorities and goals of their work.

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Table 4.1. Sociodemographic characteristics of participating 66 undergraduate students participating in a test-retest study of food security surveys

Characteristic	Participants (n=66)^a
<i>Age (years), mean ± SD</i>	19.5 ± 1.2
<i>College Classification, % (n)</i>	
Freshman	25.8% (17)
Sophomore	27.3% (18)
Junior	31.8% (21)
Senior	15.2% (10)
<i>Race/Ethnicity, % (n)</i>	
White	45.5% (30)
Black/African American	10.6% (7)
Hispanic or Latino/a	10.6% (7)
Asian/Pacific Islander	27.3% (18)
Other/Mixed	6.1% (4)
<i>Gender, % (n)</i>	
Male	27.3% (18)
Female	71.2% (47)
Nonbinary	1.5% (1)
<i>Birth Country, % (n)</i>	
United States	80.3% (53)
Other country	19.7% (13)
<i>First-Generation Student,^b % (n)</i>	24.6% (16)
<i>Sources of Financial Support,^c % (n)</i>	
Family	81.8% (54)
Employment	53.0% (35)
Government	39.4% (26)
Scholarship	51.5% (34)
Loans	42.4% (28)
Other	1.5% (1)
<i>Estimated Parental Income, % (n)</i>	
Under \$15000	3.0% (2)
\$15000 to \$34999	9.1% (6)
\$35000 to \$54999	12.1% (8)
\$55000 to \$74999	16.7% (11)
\$75000 to \$99999	12.1% (8)
\$100000 to \$149999	13.6% (9)
\$150000 or more	16.7% (11)
Don't Know	16.7% (11)

^a Sum of column may not add to 100% due to rounding; ^b Missing data: first-generation student status (n=1); ^c Sum of column will be greater than 100% as participants could select more than one source

Table 4.2. Food security survey responses and agreement between online and paper-and-pencil modalities from n=66 participating undergraduate students

Item ^a	Online affirmations, % (n)	Paper-and-pencil affirmations, % (n)	Percent Agreement	κ	ρ
2-item Food Sufficiency Screener:					
In the last 30 days, did you ever run short of money and try to make your food or your food money go further?	53.0% (35)	39.4% (26)	71.2%	0.43	0.45
HH1. Which of these statements best describes the food eaten in your household? ^b	54.6% (36)	50.0% (33)	74.2%	0.48	0.49
10-item Food Security Survey Module:					
HH2. I worried whether my food would run out before I got money to buy more. ^c	40.0% (26)	28.8% (19)	76.9%	0.50	0.51
HH3. The food that I bought just didn't last, and I didn't have enough money to get more. ^c	29.2% (19)	21.2% (14)	76.9%	0.40	0.40
HH4. I couldn't afford to eat balanced meals. ^c	40.0% (26)	37.9% (25)	75.4%	0.45	0.45
AD1. In the last 30 days, did you ever cut the size of your meals or skip meals because there wasn't enough money for food?	44.6% (29)	30.3% (20)	78.5%	0.48	0.51
AD1a. In the last 30 days, how many days did this happen?	36.9% (24)	22.7% (15)	72.7%	0.49	0.53
AD2. In the last 30 days, did you ever eat less than you felt you should because there wasn't enough money for food?	39.4% (26)	27.3% (18)	83.3%	0.40	0.41
AD3. In the last 30 days, were you ever hungry but didn't eat because there wasn't enough money for food?	27.3% (18)	22.7% (15)	92.4%	0.56	0.56
AD4. In the last 30 days, did you lose weight because there wasn't enough money for food?	9.1% (6)	1.5% (1)	92.4%	0.27	0.39
AD5. In the last 30 days, did you ever not eat for a whole day because there wasn't enough money for food?	7.6% (5)	3.0% (2)	92.4%	0.25	0.28
AD5a. In the last 30 days, how many days did this happen?	4.6% (3)	1.5% (1)	96.9%	0.49	0.56
Food Security Classification					
Food Insecure	40.9% (27)	25.8% (17)	75.8%	0.47	0.50

Note. Source: Bickel, G., Nord, M., Price, C., Hamilton, W., & Cook, J. (2000). *Guide to measuring household food security*. Retrieved from <https://www.fns.usda.gov/guide-measuring-household-food-security-revised>. κ =kappa coefficient. ρ =Spearman's correlation coefficient. ^a Missing data in online survey: HH2 (n=1), HH3 (n=1), HH4 (n=1), AD1 (n=1), AD1a (n=1), AD5a (n=1). ^b Affirmative responses included "enough but not always the kinds of foods I want," "sometimes not enough to eat," and "often not enough to eat." ^c Affirmative responses included "sometimes true" and "often true."

CHAPTER 5: COLLEGE STUDENTS' INTERPRETATIONS OF FOOD SECURITY QUESTIONS: RESULTS FROM COGNITIVE INTERVIEWS⁴

Abstract

Background. Food insecurity (FI) – the lack of sufficient access to food to maintain a healthy lifestyle – among college (i.e. post-secondary) students has become a prominent issue in the U.S. However, it is not clear if high rates of FI among students are due to the modern experience in higher education institutions or due to underlying issues in common surveying methods. To understand if there were underlying content validity issues, the present study had two primary research questions: 1) How do students interpret the USDA FSSM questionnaire items, and 2) How do responses of students experiencing FI compare with the theorized experiences and coping responses?

Methods. Thirty-three undergraduate students, aged 18- to 24-years old and fluent in English were recruited from a single land-grant university. During a 60-minute session, participants completed the U.S. Department of Agriculture's 10-item Adult Food Security Survey Module (FSSM) and then were cognitively interviewed about their responses using the think-aloud method. Interview transcripts were analysed by two researchers using a collaborative process and basic interpretative approach.

Results. Students were on average 19.5 years old (± 1.2 years), the majority were in their freshman or sophomore year, and 67% (n=22) experienced FI. Results indicated that students' interpretations of key terms – such as “money for more,” “balanced meals,” and “real hunger” –

⁴ Currently under review for publication in *BMC Public Health*

diverge from expectations. Furthermore, students categorized as food insecure reported experiences and responses to FI that varied from theoretical dimensions on the process.

Conclusions. Though limited by sample size and representativeness, the present results indicate that the content validity of the FSSM may be compromised in this population and the managed process of FI may present differently among college students. Further psychometric research on modifications to the FSSM or with new FI assessment tools should be conducted with college students.

Background

Food insecurity (FI) is defined as insufficient access to nutritionally adequate and culturally appropriate food to maintain an active and healthy lifestyle [1]. In 2017, 12% of U.S. households were estimated to experience FI [1]. A recent meta-analysis estimates that U.S. college students are at an elevated risk when compared to the general population, with 38% experiencing FI [2]. This has become a nationally recognized issue [3], as some college students experiencing FI have lower academic success as well as diminished health and well-being [4].

There are four components of U.S. household FI, originally defined by Radimer et al., [5]: 1) quantity; 2) quality; 3) psychological acceptability, and 4) social acceptability. The first component, quantity, indicates that households experiencing FI often restrict the volume and calories of their food. Quality, the second component, illustrates that food safety, nutritional density, and variety is also compromised. Individuals experiencing FI also report internal responses, such as anxiety or lack of control, and this is captured in the third component of psychological acceptability. The final component of social acceptability relates to eating patterns and acquisition strategies that many households experiencing FI may adopt due to insufficient

resources. These expected components of FI, with the exception of social acceptability, were incorporated into the U.S. Department of Agriculture's (USDA) questionnaires used to assess FI nationally [6]. Alaimo [7] provides a complimentary conceptual model on household FI risk factors (e.g., employment, housing) which lead to specific experiences (e.g., worry about food, unsuitable food) to which coping mechanisms are applied (e.g., social support, self-reliance) leading to either amelioration of FI or contribution to individual-level consequences (e.g., hunger, low diet quality, psychological suffering). Though not specific to students, this model provides a more in-depth perspective that outlines how FI at the household level presents itself and produces negative physical and psychological consequences, if not alleviated.

Students may be at higher risk of experiencing FI due to the modern experience and population of post-secondary students in the U.S. College enrolment costs are expensive and have continued to increase over time [8]. The student post-secondary population has also evolved over time, with greater inclusion of historically underserved, minority and low-income populations [9]. As universities have become more inclusive of diverse student demographics, some schools and faculty have developed new resources, policies, and support systems [10, 11], but their capacity to alleviate or prevent FI has not been clearly established [3]. In addition to these circumstances of higher education, many post-secondary students are transitioning into adulthood while enrolled [12]. The limited levels of prior experiences with food provisioning and resource management among many college students may be associated with elevated risks of FI [13].

There is a second-line of evidence that suggests students may be at higher risk of FI due to underlying issues and shortcomings of current surveying methodology. Calls have been made for general surveying protocol improvements [14]. More recently, investigations of college FI

have evaluated the surveying protocols and identified potential issues. Though prior evidence supported the inter-changeability of the various forms of the Food Security Survey Modules (FSSMs), a meta-analysis of the literature found that the various forms of the survey produced significantly different estimates of FI among college students [2]. In addition, a psychometric evaluation of the FSSMs in a cross-sectional population of 18- to 24-year-old undergraduate students found that responses within the FSSMs did not follow the expected pattern of agreement [15]. Furthermore, the estimated prevalence of FI within a single sample was dramatically lower when screening protocols were used [15]. The FSSMs were developed in the late 1980s and early 1990s based on qualitative work where low-income mothers served as key informants [16]. Additional validation work was conducted for the general population [17] and other sub-populations [18, 19], but there has been a paucity of psychometric evaluations of FI in college students.

The initial population of mothers used to develop the tool likely differs from traditionally-aged college students in a number of ways. In contrast to mothers, college students have varying levels of independence and are often not responsible for managing others in a larger household. Among students at 4-year universities in the U.S., only 6% are parents themselves [20]. In addition, it is common for young adults to report having limited experience managing food provisioning tasks [13]. Finally, the “income” of students is more difficult to define given the variability in types, formality, and distribution of financial support sources that students have [13, 15].

In addition to these differences between mothers and students, there is also the potential for differences arising from generational factors from when the surveys were developed. In the last three decades, the food landscape and provisioning tactics have changed, with more

individuals eating foods prepared away from home and eating as a secondary activity while doing something else [21, 22, 23]. In addition, a recent investigation of 18- to 24-year-old adults found that taste, which is frequently the most important factor in food decisions, was closely followed by convenience and nutrition/health [24].

Based on the possibility that the FSSMs are incorrectly assessing FI among students, the current study was undertaken. The study aims to understand if fundamental interpretations of questionnaire items may explain, in part, high rates seen in the field. The two primary research questions under investigation are: 1) How do students interpret the USDA FSSM questionnaire items, and 2) How do responses of students experiencing FI compare with the theorized experiences and coping responses?

Methods

Participant Recruitment

A random sample of undergraduate students between 18 to 24 years of age was recruited for an initial quantitative study [15]. To be eligible, respondents had to be undergraduate students, aged 18 to 24 years, and self-identify as fluent in English. Of the individuals who agreed to be contacted for future studies (n=343), participants were categorized based on their FI status dictated by responses to an online 10-item USDA FSSM (items shown in Table 5.1). If individuals responded affirmatively to three or more items, they were considered food insecure; otherwise they were categorized as food secure. Thirty-two percent of participants experienced FI (n=113) and the remaining (n=230) were food secure. Among these two classifications, participants were randomly selected to be invited to participate, with efforts to recruit equal

numbers of insecure and secure participants. When prospective participants declined to participate or did not respond after three invitations, they were replaced with a re-randomized selection from the remaining list of students.

Data Collection Protocols

Students who participated were scheduled for a 60-minute session where they completed paper-and-pencil questionnaires (both the 10-item USDA FSSM and demographic items) and were cognitively interviewed about the FSSM items. All items in the FSSM, including how they are coded as secure or insecure, are shown in Table 5.1. The survey they completed was stored, and a blank copy was used for their reference during the interview. The interview moderator read each FSSM item aloud and asked the participant to respond using think-aloud (i.e., “how did you go about responding to this question?”), comprehension (i.e., “what does the term X mean to you?”), emotional (i.e., “how did you feel about answering this question?”), and ease/confidence (i.e., “how sure of your answer are you?”) probes [25]. Additional open-ended probes (i.e., “can you tell me more about that?”) were used to elicit detailed descriptions of participants’ decision-making processes and the context that informed their choices. The interview moderator took notes during the session for later reference in creating codes. When the interview was completed, participants were compensated with \$20 USD.

Though originally randomized to recruit equal numbers of secure and insecure participants, saturation (i.e., the lack of new information revealed by additional interviews) was reached within the first eight interviews with food secure students. Therefore, to maximize information gained, investigators decided that all future interviews scheduled should be with students experiencing FI. An additional three interviews were conducted with food secure

students (for a total of n=11 food secure interviewees) due to previously scheduled and confirmed sessions.

Interviews were recorded with a digital recorder and recordings were transcribed verbatim using an external transcribing service. Transcriptions were verified alongside the original recording by two research assistants, independently, to confirm accuracy. All participants consented in writing to participate, and the above protocols were approved by the institutional review board for research involving human subjects at the University of Illinois at Urbana-Champaign (IRB#18224).

Analyses

Quantitative FI and demographic information were analysed and summarized using STATA/MP 14.1 (StataCorp, LP, College Station, Texas, U.S.). Transcripts were analysed and coded through a collaborative process by two researchers using a basic interpretative approach. Coding began with the generation of many codes (i.e., “open coding”) by each researcher independently, as new concepts occurred. Half of the interviews (n=17) were randomly selected to be open-coded. Each openly coded interview was discussed in-person by both researchers to confirm that identified codes were consistently used. During these meetings, novel codes were defined and integrated in future openly coded transcripts. A working codebook was developed based on these meetings and continually updated as new codes emerged. Both researchers reviewed the codebook in light of the primary research questions before combining, refining, and categorizing codes. Formal definitions and examples were added to this draft of the codebook. The codebook was then used to “double-code” four transcripts, wherein each researcher independently used the codebook to code each interview using the predefined codes and marking

transcript quotes that were not clear. Agreement of researchers on these double-coded transcripts was greater than 80%. The entire sample of transcripts was then coded by one of the two researchers, independently, using the final codebook and meeting to decide how to code any unclear quotes. The final transcripts with coded segments were entered into MAXQDA 2018 (VERBI GmbH, Berlin, Germany) to assist with final analysis and summarization.

Results

Participant Characteristics

Sociodemographic characteristics of participants are shown in Table 5.2. Participants on average were 19.5 years old (± 1.2 years) and the majority (58%) were in their freshman or sophomore year. A high proportion of respondents were white (58%), identified as female (70%), and were born in the U.S. (91%). Characteristics of participants deviate from the overall university's undergraduate student body, particularly in race, gender identity, and proportion of senior students. Living situation and financial resources available were diverse, with approximately half of participants using a dining hall meal plan and equal proportions of participants living in on-campus and off-campus residences. Though participants estimated a variety of parental income levels, the majority (79%) perceived that they grew up in a middle class household. The majority (79%) also received some financial support from their families.

Responses to each item of the FSSM are shown in Figure 5.1 to illustrate the quantitative response pattern among included students. Theoretically, the items are ordered from lowest to highest severity, and the number of affirmative responses should decrease for each item based on its order in the FSSM. However, in the current sample the fourth item (affording balanced meals)

and fifth item (cutting and skipping meals) were the two items most frequently affirmed. In addition, a considerable portion (27%) selected the “don’t know” option for item AD4, which asks about losing weight.

Survey Interpretation

Throughout the cognitive interview transcripts, students’ comments on their prior experience with the survey topics and their overall response to the questionnaire were coded to capture their general responses to the survey. Responses were summarized and compared by resources available (e.g., dining hall meal plans, familial support) as well as FSSM classification.

When asked what they believed the survey measured, all interviewees summarized the questionnaire in terms of hunger or general food behaviours among college students. Many used terms of “access,” “availability,” and “utilization,” which are some of the primary pillars used by the Food and Agriculture Organization (FAO) to assess population-level FI rates [26]. A minority of participants were familiar with FI and identified it in those terms.

Students comments indicated there were some general difficulties that arose as they approached the questionnaire. Estimating the frequency of experiences over the last thirty days was perceived as difficult for many, so making reasoned guesses was common. For example, one student noted: *“For these last 30 days, I usually just think of the past two weeks cause I can't really think further than that”* (18 years old, female, food secure). Both secure and insecure students mentioned generalizing over the semester period or referring to the previous week to use as an estimate. For other students, the time range or qualifying monetary statements were completely overlooked. Though the cognitive interview took place immediately after participants had completed the survey, it was common for students to forget how they had responded. Some

indicated that they did not remember certain questions altogether. Students provided suggestions to modify the tool, particularly to include more response choices for the first three items. The response choice of “often true” felt extreme for many, but they were unsure if “sometimes true” reflected the food management issues they had.

Finally, a few respondents experiencing FI felt frustrated that their responses, which they thought were accurate, would categorize them as food insecure when they did not see themselves this way.

“I think about food insecurity I don’t see myself as someone who is food insecure and so when I say yes to these questions, I’m thinking like I’m making myself sound like I’m food insecure when really I’m not” (19 years old, female, food insecure).

These general-level interpretations of the survey provide insights on the way college students approach the FSSM, but greater detail about specific issues that students had are apparent when the interviews were further analysed. Therefore, the next section outlines students’ interpretations of key terms within the survey.

Money for more. The stipulation that experiences are related to monetary restraints is present in all FSSM items with clauses such as “money to get more” or “because there wasn’t enough money.” However, these clauses are not consistently interpreted due to the heterogeneity of student resources. Resources range in formality and stability as well as their basis as financial or specifically food-related (i.e., dining meal plans or physical food available). Resources could include, but were not limited to, parental (or other family) support, a dining hall meal plan (of which, there were four offered by the university), wages from prior or current employment, food provided by friends or roommate(s), food available at events or provided by organizations, and

financial support provided through scholarships or other aid sources. Given the variety of resources available to students, the term “money to get more” was interpreted in various ways.

“How much money's in my bank account. All the money that I earned over the summer”
(19 years old, female, food secure).

“I didn't have to worry about [my food] necessarily running out and then paying another instalment because I pay [for the dining hall] upfront at the beginning of the semester for the food” (20 years old, female, food secure).

“When I think of money for food, I'm thinking about um what I have for meal swipes and [campus convenience store] credits” (19 years old, female, food insecure).

For those that had dining hall meal plans, they often used this as a sole reference and ignored other resources when answering items, serving as a cognitive heuristic to ease their response choice.

“I'm just going to think of the dining hall because that's the, the easiest way to look at it. You know for [campus convenience stores] or uh, you know, somewhere I can buy food for myself, there's a lot of different, you know, variables related to that, so we'll just forget about that” (18 years old, male, food secure).

Some interviewees suggested that meal plans be listed explicitly alongside references to money to make it clear that they should be referencing both resources.

When comparing students by FI status, students with food security were more likely to indicate parental support and/or a meal plan provided the majority of their food resources. No students with food security mentioned current employment, friends/roommates, or events/organizations as a personal food resource. Students with food security were also less likely to mention worrying about their resources or managing them tightly. Students

experiencing FI, in contrast, referenced a spectrum of food and financial resources. Despite this variety, and often piece-meal resource landscape, many students experiencing FI interpreted “money for more” as simply their meal plan, the money in their bank account, or a pre-determined food budget. A few students experiencing FI had trouble voicing what they were referencing when they saw the financial qualifier. One student experiencing FI described a working tabulation of their expenses and expected influxes of financial support as their reference point, revealing the chaotic nature of their financial situation.

Among students experiencing FI who were carefully managing their resources, many were hesitant to answer items affirmatively because they interpreted “wasn’t enough money” as absolutely zero financial resources. One student described this as: *“Not yes because I’ve never been like in the negatives or like had no cash or was at like completely zero on like my debit card”* (21 years old, female, food insecure).

Balanced meals. The third item of the FSSM, often referred to as HH4, asks whether participants can afford balanced meals. This item expects respondents to have a concept of balanced meals, and interviewees were asked to define their interpretation of this term. The most common definition of balanced meals, among both insecure and secure students, were meals where all (or most) food groups were present. Many referenced U.S. dietary guidelines – either the Food Pyramid or MyPlate – as their idea of a balanced meal: *“I mean, balanced meals, they’re like fruits, vegetables, bread, chicken, meat, protein, like all that stuff. The food triangle, like all that stuff”* (21 years old, female, food insecure). Other respondents had even greater standards that incorporated exclusively organic items or included supplements. One student experiencing FI felt assured they had a balanced diet because they analysed their nutritional intake. In contrast, the majority of respondents felt their diets fell short of these standards.

However, it was difficult for some participants to separate whether this was due to financial restraints. One student discussed the inconveniences of eating healthfully: *“I don't want to go out to like buy all these ingredients. And it's like such a hassle. So I think that's why I can't afford to eat balanced meals”* (18 years old, female, food insecure). Another respondent answered affirmatively because they felt that inherently their diet was unhealthy if they spent little on it: *“I just don't like spending so much money on like super healthy things cause I feel like they're really expensive”* (21 years old, female, food insecure). Respondents with food security who did not eat healthfully felt it was straightforward that this was a personal choice or influenced by other priorities: *“So... couldn't afford to eat balanced meals. I can afford it. I would just have to spend more”* (19 years old, female, food secure).

Among students on meal plans, they felt they could make balanced meals in the dining hall but were restricted by the hours they could attend and number of meals on their plan. If students could not attend regular dining hours, they used meal plan credits at on-campus convenience stores and creating balanced meals was more difficult because snack items were the primary food available. *“Like with [campus convenience store] credits, like the chips thing. You shouldn't eat chips as a meal, but when you have nothing else to do, you eat just water and chips”* (19 years old, female, food insecure).

The balanced meal question elicited negative feelings among some respondents experiencing FI, as they reflected on how financial constraints impacted their diets: *“It made me a bit sad because I realized that I'm eating pretty terribly, and I should be supporting my body better than I am”* (18 years old, female, food insecure). Many students experiencing FI felt shame that they were not meeting perceived cultural standards to eat healthfully. However, a minority of students categorized as food insecure felt that poor dietary habits were the norm for

students and not something to worry about: *“It seems like such a college kid problem. That's why I laugh so much, cause it's just ramen is just what you eat”* (20 years old, female, food insecure).

As interviewees discussed the item, participants categorized as food insecure who had not considered the financial restraints aspect of the item expressed a desire to change their response. They remarked that talking about it made them consider non-financial factors like class schedules and extracurricular activities that impacted their dietary choices.

Eating less than should. The sixth item of the FSSM asks whether a respondent ate less than they felt they should (item AD2). This item follows another item asking whether respondents skipped or cut the size of their meals (item AD1). Students were comfortable and confident responding to this item and found it easy overall. However, respondents indicated that they felt these items were similar. Interviewees felt that if they had answered “yes” to skipping meals then that meant they were eating less and so they should answer “yes” again. The practices of skipping meals and cutting the size of meals were often referenced by interviewees experiencing FI explained their thought process for responding to AD2.

“Um, yes because the last one was a yes and it was pretty easy since it was such a similar question. I felt like this question just reinstates the last question” (18 years old, female, food insecure).

A few students reported unique approaches to this item. One participant used their hunger levels to determine if they ate less than they should. Another student experiencing FI approached AD2 by evaluating their grocery shopping and describing how they spent less money on groceries than they actually ate because they relied on free food resources:

“If I spent \$40 a week or something like that on food and ... I'm trying to put this to number because that's how my brain sort of works, but I eat 45-ish dollars worth of food”

over that week, that five dollars that came from eating something at some kind of organization, that's sorta how I answered it” (21 years old, male, food insecure).

For students on meal plans, their responses were complicated by the buffet-style used in the facilities. They were inclined to answer negatively about eating less because they could eat as much as they would like during a meal, even if they only ate one or two meals a day.

Despite these remarks about the similarities of AD1 and AD2, participants did not respond to them identically when they filled out the survey (see Figure 5.1). Of the fourteen affirmative response to AD1, only ten respondents also affirmed AD2. In addition, there were two respondents who affirmed AD2 after responding to AD1 negatively. Therefore, participants had some variation in interpretation and actual survey responses that were not widely reflected in the cognitive interviews. This may, in part, be due to the lack of memory and concentration when completing the survey.

Real hunger. As interviewees explained their response rationale to the seventh item of the FSSM (AD3), which asks respondents whether they were hungry and did not eat, the term “real hunger” was commonly used. Students thought of stereotypical hungry people and not themselves: *“People usually associate are you always hungry with like homeless and the hungry, and you got to feed the hungry and the poor”* (18 years old, female, food insecure). Discomfort answering this item arose among some students experiencing FI when they had otherwise avoided thinking about their experiences of physical hunger. Comments among students categorized as food insecure revealed they commonly compared their experiences of hunger against their personal standards of “real hunger,” often discounting their situation.

“Hungry is kind of like a broad definition you know, like I was not like starving, but I mean I’m hungry right now, and I skipped lunch. (Soft laugh) But, it’s not like painful hungry or like horrible hungry. It’s fine” (18 years old, male, food insecure).

“Like 24 hours is like hungry. Like I don’t know. I feel like if I don’t wait that long then I’m not really, then it’s like, ‘you’re just a little bit hungry,’ or something like that” (19 years old, female, food insecure).

“For this question I’m thinking about like the times that I was so hungry I was like, oh, my God, I’m only thinking about how hungry I was” (21 years old, male, food insecure).

The distinction of real hunger versus personal hunger was also mentioned by students categorized as food secure. However, students with food security could easily identify that their experiences of hunger were not related to money shortcomings in contrast to students experiencing FI who had to judge if their hunger was “severe” enough. Skipping meals or having days where no food was consumed were used as a proxy to affirm or disaffirm this question for some students categorized as food insecure. However, the acceptability of skipping meals as a measure of real hunger varied across students. These heuristics used by students distil this item into terms that are similar to other items on the FSSM.

Weight loss. Respondents are asked if they lost weight because they did not have enough money for food in the eighth question (AD4) of the FSSM. Many interviewees indicated that they did not know their weight because they were not interested in tracking it, did not own a scale, or did not know where they could weigh themselves on campus. This often lowered the confidence that students had about their responses. Despite this, the quantifiable aspect of weight loss made this item straightforward for individuals to respond to for those that knew their weight. Students who did not regularly weigh themselves felt the item was difficult unless they had opted

to select “don’t know.” However, some students who selected “don’t know” would apologize because they believed that this was a “wrong” answer for surveys. One respondent categorized as food insecure discussed how they had previously lost weight due to food and financial issues, but did not feel it was distressing and had recently adapted to their situation so had answered “no”.

Some respondents experiencing FI answered negatively to this item but revealed there were factors outside of food and finances that impacted their answers. For example, one respondent relied solely on their meal plan for food but had other commitments during open dining hall hours: *“I think I've lost some weight, but I don't know. If it is, it's not because of lack of money for food, it's because of lack of time for food”* (19 years old, female, food insecure). Other students experiencing FI felt that no matter how much they ate, their weight would not reflect it because they had elevated metabolism levels or were still growing. One student categorized as food insecure who did not weigh themselves tried to estimate if they lost weight based on their energy level but found it difficult to understand if their fatigue was a product of malnutrition from skipping meals or from academic pressures. Another student experiencing FI felt their weight fluctuated week to week based on how tightly they were rationing their food, but they chose to answer “no” because short-term weight changes were not concerning to them.

Respondents with food security were comfortable answering this weight-related item. When asked if the item elicited any emotional response, students talked about how dissatisfaction with one’s weight would make someone uncomfortable answering this question. This idea that high weight was negative and the item may provoke shameful feelings, as well as the converse that low or losing weight was inherently positive, was often discussed by both secure and insecure students.

Food Insecurity Experiences

Interviews with students categorized as food insecure were used to further understand the process and circumstances of FI among students. The transcripts were compared with the four components of household (or individual) FI, originally conceptualized by Radimer et al. [5], which were used to develop the USDA FSSMs [6]. These components are: 1) quantity; 2) quality; 3) psychological acceptability, and 4) social acceptability.

Quantity. The first component of FI is quantity of food – specifically that individuals have access to sufficient caloric intake. It was common for students experiencing FI to lower the quantity of their intake by cutting meal size or skipping meals. A few students mentioned being hungry or not eating to fullness, but these instances were often disregarded and not considered “real hunger.” For many students, experiencing physical hunger or cravings for certain foods would drive them to eat even if they felt they could not afford it. Whether these experiences translated to suboptimal caloric intake was unclear as some felt they had adjusted to the new eating patterns: *“I guess because of that worry that I won't have enough credits, I started eating less and it just became less of a worry, became a new schedule, new habit”* (19 years old, female, food insecure).

For students with dining hall meal plans, skipping meals did not always translate into lower overall intake because of the buffet-style service at the meals they attended.

“I feel like to say that I don't have enough money for food is like a bit of exaggeration cuz with the meal plan like you have enough, it's just at weird intervals” (19 years old, female, food insecure).

Weight loss is often used as an indicator of sub-optimal caloric intake, but this was difficult to use based on the interpretations of the term (discussed above). However, there were a

few students who indicated they made severe caloric restrictions. One student estimated they would restrict their intake to 400-600 kcals per day. Another student who went entire days without eating avoided expending energy (i.e., not bicycling to campus) on these days.

Quality. Individuals experiencing FI may compromise the quality and safety of their foods, elevating their risk of nutrition inadequacies or illnesses. Most students categorized as food insecure reported the quality of their food was low, specifically referencing low nutritional value and cost of ingredients. One FI student stated *“I'm usually eating like dollar cheeseburgers from [fast food restaurants], or \$0.50 cans of [prepared pasta], or just s--t food”* (20 years old, female, food insecure). Students would forgo purchasing healthy items to save money and prioritize foods that satiated them: *“As much as I want to get vegetables, vegetables are not going to fill me up”* (21 years old, female, food insecure). The primary exception to this was among students with meal plans who felt they could eat a variety of healthful foods in the dining halls, given the buffet-style distribution. Though, a few students categorized as food insecure were concerned about the taste quality and food safety standards in these facilities.

Cost and financial restraints were a dominant influencing factor on food decisions among those experiencing FI, but many students also referenced the role of convenience and other priorities in diminishing the quality of their diets. One student reflected that: *“It's just like it's so much easier to buy cheaper, non-healthy foods on campus than it is to buy healthy foods”* (22 years old, female, food insecure). Limited preparation capabilities or skills were often cited as rationale for why students purchased and ate foods they perceived as lower quality convenience items. Many, though not all, students reported their diets were low quality, but it was unclear whether they would be at risk for nutritional inadequacies. It is also unclear whether these patterns vary from the average student with food security who is mindful of their expenses and

sees food as an area where costs can be reduced. The reference standard for quality foods is ambiguous for most respondents, created based on personal and cultural norms. However, one interviewee used their studies in biochemistry to evaluate the nutritional adequacy of the foods they purchased with their limited funds.

Psychological acceptability. The third component captures how an individual experiencing FI respond internally to their situation. Responses often included anxiety about food and feelings that one's choices are unacceptably restricted or out of their control. For interviewees experiencing FI, unplanned expenses felt alarming and like tests of adulthood. When students felt they needed to ask for support from their family, they often reported hesitating to reach out and felt guilty or like a burden.

Among students on dining hall meal plans, many reported feeling that they were restricted to eating only what the plan could cover: *"Like I can't eat this meal because I'm gonna like- because I'm not gonna- I'm gonna run out of [meal credits]"* (19 years old, female, food insecure). This restriction was commonly reported even if they had resources to cover external expenses. One student who had external funds noted that: *"I just hate spending my money on food"* (18 years old, female, food insecure). Trying to restrict one's self only to the meal plan allotment could also produce a semi-daily task of checking their plan's remaining balance online or conducting "mental math". One student described their process when trying to decide if they could use their meal credits: *"How long can I last without um using a credit? Can I sacrifice a credit for another day?"* (19 years old, female, food insecure). This task often produced anxiety: *"You don't even get enough for two meals a day, so I was- I do worry about that a lot"* (19 years old, female, food insecure).

Many students felt powerless about their situation: *“There's nothing wrong with skipping meals if you have to do it. You do what you got to do”* (21 years old, male, food insecure). They would avoid thinking about it or instead focus on the next time they would be able to eat. Many students rationalized their food restrictions as normal, regardless of the severity they described. This lack of control was more common among students who also discussed food access issues during their upbringing, as the circumstances were normal to them and they had not expected things to be different in college.

There were also responses indicating that the restrictions students made were not worrisome or they felt not consciously impacted by them. After indicating they skipped meals or were eating unbalanced diets, students would say they were not concerned about these practices.

“When you're at a dining hall, it's like so many options and opportunities so even though you have a strict amount of time you can go, that's not, you still have access to food...I would consider it a moderate inconvenience” (19 years old, female, food insecure).

Social acceptability. The final component, social acceptability, evaluates whether an individual has to deviate from normal food acquisition and consumption patterns due to restriction. Specifically, many individuals experiencing FI cannot eat in a normal pattern of meals and they may have to acquire food through non-conventional sources. Commonly, a normal meal pattern is perceived as three meals a day with flexibility to accommodate additional snacks. However, individuals across the U.S. have dietary patterns that can vary in number and size of eating occasions, regardless of their financial resources.

It was common for students categorized as food insecure to report eating two meals or less a day and supplementing this with smaller snack items. Many students experiencing FI also referenced using inexpensive low-quality snack items to substitute for full meals. However, it

was not always clear if students chose their eating patterns or were “forced” into them through external circumstances. When a student was reflecting on whether they would prefer not to skip meals and eat three meals a day, it was difficult for them to consider this situation because they felt that was an unachievable scenario and their pattern of skipping meals was described as *“So normal to me now”* (19 years old, female, food insecure).

One student provided insights on how financial restraints broadly impacted her eating: *“Always trying to be mindful of money kind of has made me like a little less inclined to just feed myself naturally like how I would need to eat”* (19 years old, female, food insecure). Though specific eating patterns and choices made by students experiencing FI due to limited finances were not frequently described as socially undesirable, a few specific instances clearly deviated from expected practices. For example, restricting one’s self to eating only a can of beans for dinner: *“I will eat one can of beans and then I’ll say okay I can’t eat anymore because I need this next can of beans for tomorrow”* (19 years old, female, food insecure). Or, drinking water instead of eating meals and avoiding food stimuli to ignore one’s hunger: *“I’ll drink water, and I just don’t walk past like [fast food restaurant], or something like that, or like where I can smell it”* (19 years old, female, food insecure). In addition, a few students experiencing FI with meal plans would discuss needing to binge eat in the dining hall because of the infrequent eating occasions they had available to them with plans that covered two or less meals per day.

There was also the potential for social consequences based on the food management processes students had to undertake. One student participated in social gatherings, but would lie about why they were not eating: *“I just, I say I’m not hungry or that kind of stuff, like I come up with excuses”* (21 years old, female, food insecure). One student received additional food money from their parents to eat with friends: *“Cause my parents also didn’t want me to like back out of*

like social events just cause I was out of money” (18 years old, female, food insecure). In contrast, other students described declining offers to eat with friends because of their financial restrictions. A few students mentioned using less conventional food resources (i.e., food pantries, free food events, community organizations) to supplement their diets, but this was not commonplace for most students categorized as food insecure.

Food Insecurity Coping Strategies

The final analysis of food insecure interviews evaluated whether students enacted theorized coping mechanisms. Alaimo [7] outlined how individuals responded to and coped with FI based on several seminal works. Coping responses are broadly categorized as self-reliance, seeking social support, seeking formal support, and seeking emergency support.

Self-reliance. Relying on one’s self (e.g., resource management, rationing) and hiding their personal situation from others is one coping mechanism. Rationing food resources (i.e., meal plan credits, multi-item packaged foods) was common for many students experiencing FI. This included portioning out food items: *“For breakfast or something, I’ll only eat like half of it. And then that makes it last twice as long, instead of eating the whole bagel”* (19 years old, female, food insecure) and rationing dining hall meal allotments: *“I- I’ve skipped meals a lot because I’m scared I’m going to run out of [meal credits] like later in the week”* (19 years old, female, food insecure).

As students experiencing FI became accustomed to being at the university, many reported learning and adapting their approaches and mindset to operate within their restraints. For many students, this was their first time being responsible for managing their money and food resources. One student described that: *“It was kind of different because I was used to somebody having meals for me, now I have to figure out, ‘Okay, can I eat now? Or can I eat later?’”* (19 years old,

female, food insecure). Learned approaches to self-reliance included building cooking confidence, meal prepping, identifying free food resources, learning about the dining hall hours and meal structure, budgeting, or making various adjustments to their eating pattern.

Alongside a reliance on one's self, many interviewees discussed feeling like a burden if they relied on others. For example, one student remarked that: *"I would hate to kind of be the inconveniencing factors in someone's life, even if it's like 10 or \$20. It's 10 or \$20 they could have spent elsewhere"* (19 years old, female, food insecure). Many students were acutely aware of the financial support that their families provided to pay for other expenses:

"I don't really want to bother them with like paying for more than what they're already paying for because like the meal plans are like really expensive, and like I don't- I don't know, I guess I feel uncomfortable asking them for more money" (19 years old, female, food insecure).

Additionally, some students felt alienated and that they should hide their situation from others. One student avoided discussing their situation with others: *"If I ever told someone that I'm spending like 10 dollars of food a week they would be pretty shocked and they'd think that I'm not eating properly"* (19 years old, female, food insecure). Another student reflected that it would be shameful to discuss financial issues on a campus where so many students appear to come from high-income families.

"When you're on campus, there's like a healthy amount of people that are really like wealthy. Like I've even experienced that. And it's like you don't want to have like a conversation with somebody who's like, can get like whatever they want while you can't afford something" (19 years old, female, food insecure).

During interviews where students experiencing FI discussed their approaches to food resource management, it was common for students to rationalize their situation and dismiss it as normal. One student felt: *“That’s not food insecurity, not eating breakfast (laughs), but you know a lot of people do that”* (19 years old, female, food insecure). The student who reported eating single food items for meals, such as a can of beans, asserted that: *“I am getting adequate nutrition and therefore it doesn't matter whether or not I'm eating meals”* (19 years old, female, food insecure).

Seeking social support. Another coping response is to seek support from social networks (i.e., friends, family, and community members). It was commonplace for students experiencing FI to discuss various members of their social network that provided financial and food support to them. When friends were referenced, many times support was informal and did not require students disclose any hardships.

“My roommates usually make those oven pizzas and stuff and like there's obviously more than just one person to eat, so ... and they don't want to save it because it's just going to get kind of weird in the fridge, so they always like give me a slice” (21 years old, male, food insecure).

Informality and anonymity was also true when students sought support from community organizations or events. They were able to receive free food without indicating any atypical need by attending events or club meetings on campus.

“There’s a lot of shame around food insecurity, I think it’s great to have events there, you know for cultural or you know some sort of gathering of sorts (laughs) that have food. Cuz I’d, I did that too. There’s like a lecture series on Friday that I like to go to” (19 years old, female, food insecure).

However, when needs became greater than single items or meals, students often had more hesitations about reaching out to their social support systems. Oftentimes their desire for independence and “status as an adult” was threatened if they had to call their parents or other family members for money. For some students, this meant they would skip meals instead of reaching out. For others, they acknowledged their desire for independence, but ultimately decided to ask for help: *“The fact is I could if I really don't have anything to eat, like I'm never going to skip a full meal and just be hungry”* (19 years old, female, food insecure).

Seeking formal support. Seeking formal support to increase one’s food supply through government assistance or employment is another coping strategy. Many of the students experiencing FI were employed while enrolled in school or had worked to ensure they had savings accrued before the semester. One student, who had initially answered the FSSM as food insecure during the screening process, felt their circumstances were in the midst of change because they had attained a job between the initial survey and the interview process. As a vegetarian using the dining hall meal plan for the majority of their food, this student felt their options were limited. They reached out to dining services to request menu alterations but also noted: *“That also led me to apply for jobs”* (19 years old, female, food insecure), so they could buy food from external sources.

Though likely a large source of financial resources for food, no other students discussed their jobs explicitly as needed to purchase food. One student specifically sought employment to build her social network and indicated: *“Like the money is kind of like a bonus”* (19 years old, female, food insecure). Only one student reported using SNAP benefits, in addition to their other resources (e.g., employment, family), to ensure they had sufficient money for food.

Seeking emergency support. The final coping response is seeking support from emergency sources. This can include visiting food pantries, begging for food, and stealing food. Emergency support seeking was not common among the sample of students experiencing FI interviewed. No students discussed stealing or begging for food, but food pantries were discussed. However, many times when food pantries were discussed it was in the context of helping “real” hungry people such as homeless or families struggling to feed their children. Some students noted that food pantries would be helpful to serve other students experiencing FI, but there were only two students interviewed who explicitly discussed personal food pantry use. They both lived off-campus and used an on-campus food pantry one time per week as a supplement to purchased groceries. One of the students using the pantry connected this to her cultural upbringing and explained her perspective: *“I was always taught when it comes to food you don't guess it. You should never be starving”* (21 years old, female, food insecure). In contrast, when other students discussed food pantries, they felt they would be too prideful and uncomfortable to use them.

Discussion

The objective of the current study was to capture how traditional undergraduate college students understand the 10 items of the FSSM that query about adult experiences with FI. In addition, interviews with college students experiencing FI provided ample perspective to compare their experiences with theorized elements of FI. The interpretations of key aspects of the FSSM indicate the content validity for this population may be compromised. This was of particular concern based on the interpretations of “money for more” clauses, responses to the

“balanced meal” item, and difficulties addressing questions about weight loss related to food insufficiency. In addition, students experiencing FI reported a variety of coping responses and experiences, indicating that the theoretical “managed process,” developed for the general population [5, 16], may not be appropriate for post-secondary students. It is critical that future research distinguish experiences related to FI from the dietary choices and resource management experiences that are primarily related to being a student and/or a young adult.

The potential misinterpretations of many key terms in the FSSM aligns with prior studies that have indicated the current surveying methodology may be inappropriate for the college student population [2, 15]. Nikolaus et al. [15] found that item infit and outfit statistics were compromised for the “balanced meals” item as well as the items related to losing weight and skipping meals. This corroborates the various interpretations and response patterns found in the current sample of students. The high rates of FI reported in the recent meta-analysis [2] may, in part, be related to the various interpretations and response issues that students reported having related to the FSSM.

The qualitative findings that there may be inaccuracies in the FSSM among college students are similar, in some respects, to previous work using qualitative investigations to understand how other populations understand the FSSMs. Foster et al., [27] compared mothers’ and fathers’ interpretations of the 18-item USDA Household FSSM, finding that fathers had unique interpretations of the terms “balanced meals” and “household.” In addition, they also reported that fathers had limited anxiety as a response to FI [27]. Though gender was not a segmentation strategy in the current study, many students rationalized or normalized their experiences with FI. This suggests that psychological acceptability may be an inessential element assessed when evaluating college FI. Similar to the current findings, previous work found that

the term “balanced meals” was also a potential source of error and misinterpretation when this was evaluated through interviews with Hawai’ian residents [19]. Though quality is an essential component of FI, it is unclear if using the key term of “balanced meals” is the best method. This may be particularly true among high-school educated young adults pursuing a college education. The findings illustrated the high standards with which many students compared their diets. Though nutritious dietary patterns are ideal for all Americans, in a commentary on measuring FI, the quality aspect is described as acquiring essential nutrients, not optimizing diet quality [14]. It is important that the indicator of quality in a FSSM evaluate potential compromises and undernutrition, not commonplace shortcomings that many adults face in meeting dietary guidelines [28].

In addition to the investigations of specific FSSM items, the current results also provided an in-depth understanding of students’ FI experiences. This is not the first qualitative investigation of FI among college students [29, 30], but to the authors’ knowledge it is the first to formally analyse experiences against theoretical elements of FI. Common sentiments that students experiencing FI prioritize satiety, cut the size or skip meals, and eat lower quality convenience foods was also reported in focus groups of college students in California [30]. In later semi-structured interviews among a separate sample of students in California, the impact of FI on students’ psychological wellbeing, producing anxiety, and social relationships was described [29]. The current results indicate there is similarity between the experiences described by students enrolled in public California universities and students experiencing FI in the current study. However, the adequacy of the FSSMs to capture the California university students’ sentiments was not described.

This study, alongside other quantitative investigations [2, 15], reveals current methods may not be accurately estimating the FI among students. Future research studies will need to, first, evaluate and confirm if these findings are similar or different when surveying different student populations. Specifically, qualitative and quantitative psychometrics tests are warranted in students at 2-year schools, non-traditional aged students, and among graduate students. Beyond these replications, in-depth investigations developing and testing a new FI questionnaire for this population may be valuable. However, drastic changes may complicate comparisons with national FI estimates. It is possible that making subtle modifications or adding supplementary items to the existing FSSMs could be suitable to address psychometric issues. Alternatively, many studies have investigated very low food security, the most severe form of FI, among students [31], and it is possible that this specific classification could better distinguish FI among students. Tests of concurrent validity, evaluating FI alongside other theorized risk factors (race, financial support, etc.), consequences (diet quality, mental health, etc.), and proxies for FI, would also be a valuable contribution to the literature. Until appropriate measures of FI among students are established, evaluations of suggested initiatives [3] will be compromised.

The findings of the current study should be made with considerations to the limitations of the study design. The interviews were limited to the 10 adult items in USDA FSSM. Recent psychometric research indicates that the most accurate assessments of FI may be produced with the addition of a 2-item food sufficiency screener [15], so qualitative investigations that include these additional questions may be valuable. In addition, the qualitative approach naturally limits the ability to quantify the impact of the issues identified. Given the labour-intensive needs to conduct in-depth interviews, the number of students included in most qualitative investigations, including the current study, was limited. However, saturation (i.e., the continued vocalization of

common topics and themes) was achieved within the included interviews for the primary research question related to the appropriateness of the FSSM. The study was limited to one 4-year university with traditionally-aged undergraduate students, so generalizability to other contexts is limited.

Conclusions

It is clear, based on the current results and other published literature on the topic, that FI is a pressing issue among some post-secondary students in the U.S. However, the current FSSMs may not be the best tools to assess FI in this population. Testing modifications to the current FSSMs or development of new tools will be essential to better prevent and alleviate these issues among students. Diverging opinions have been debated with some individuals asking whether students experiencing FI should be enrolled in college, a large personal expense. This sentiment was reflected by one interviewed student experiencing FI.

“There's so many- So many angry older people in line who would like to remind you that you don't have to go to college, or you don't have to drive a car, or you don't have to- You don't have to have nice clothes. If I was really hungry, I shouldn't have a cell phone. If I was really hungry, I wouldn't have like a laptop you know” (20 years old, female, food insecure).

However, in the current economy, a post-secondary education in the U.S. is no longer considered optional by many based on the long-term implications of a college education [32]. Given this, it is likely that the proportion of young adults seeking college degrees will only continue to grow. To ensure that FI is prevented, alongside the myriad of downstream health and

social consequences, accurate surveys to measure the current issues and changes over time will be essential.

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Table 5.1. Questionnaire items and coding of response options as insecure or secure in the 10-item Food Security Survey Module^a

<i>Item</i>	<i>Affirmative (Insecure) Response(s)</i>	<i>Negative (Secure) Response(s)</i>
10-item Food Security Survey Module:		
HH2. I worried whether my food would run out before I got money to buy more.	Often true, Sometimes true	Never true, Don't know
HH3. The food that I bought just didn't last, and I didn't have enough money to get more.	Often true, Sometimes true	Never true, Don't know
HH4. I couldn't afford to eat balanced meals.	Often true, Sometimes true	Never true, Don't know
AD1. In the last 30 days, did you ever cut the size of your meals or skip meals because there wasn't enough money for food?	Yes	No, Don't know
AD1a. In the last 30 days, how many days did this happen?	≥3 days	1-2 days
AD2. In the last 30 days, did you ever eat less than you felt you should because there wasn't enough money for food?	Yes	No, Don't know
AD3. In the last 30 days, were you ever hungry but didn't eat because there wasn't enough money for food?	Yes	No, Don't know
AD4. In the last 30 days, did you lose weight because there wasn't enough money for food?	Yes	No, Don't know
AD5. In the last 30 days, did you ever not eat for a whole day because there wasn't enough money for food?	Yes	No, Don't know
AD5a. In the last 30 days, how many days did this happen?	≥3 days	1-2 days

Source: Bickel, G., Nord, M., Price, C., Hamilton, W., & Cook, J. (2000). Guide to measuring household food security. Retrieved from <https://www.fns.usda.gov/guide-measuring-household-food-security-revised>

Table 5.2. Sociodemographic characteristics of undergraduate students who participated in cognitive interviews and comparison with university's undergraduate student body.

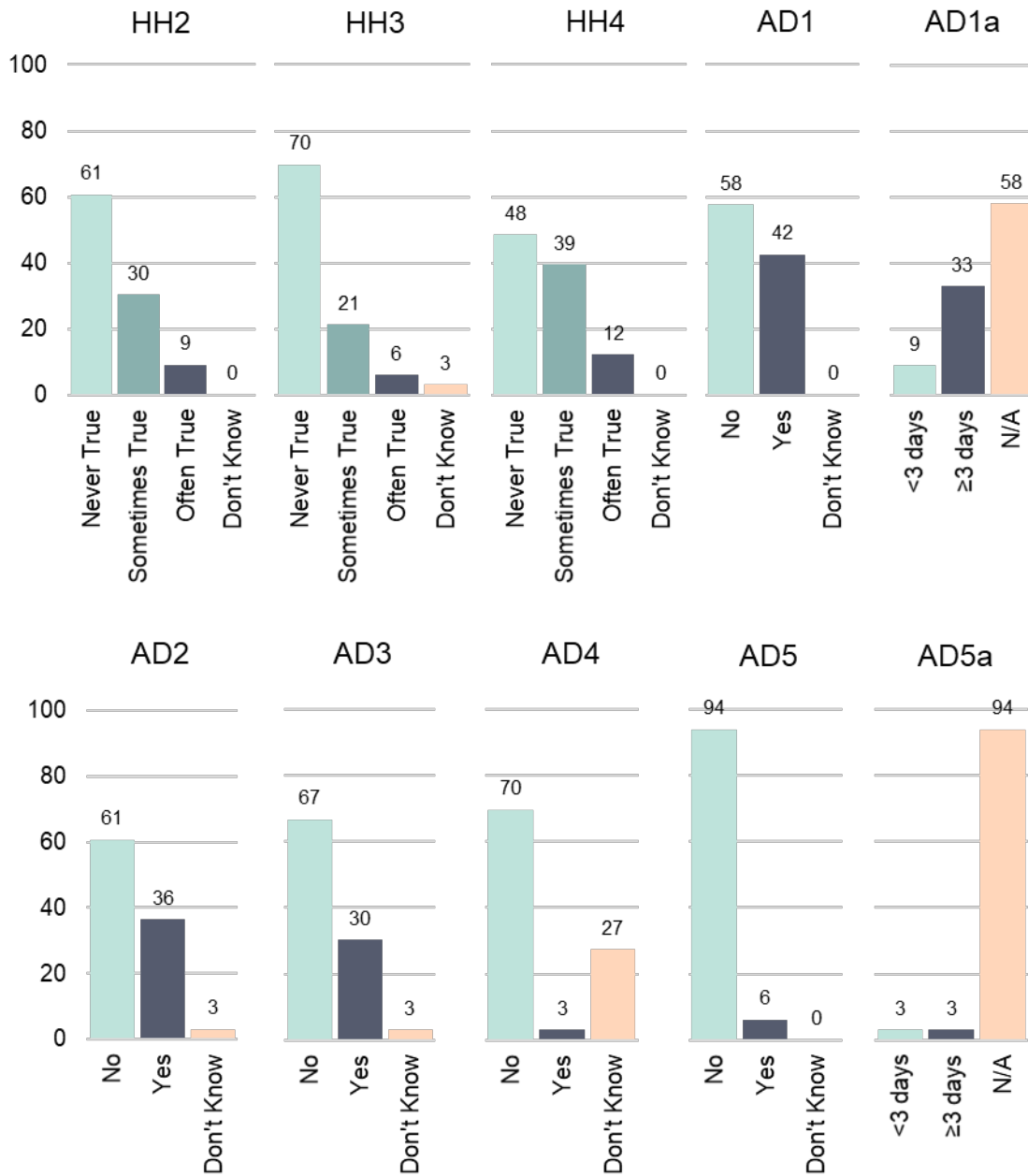
Characteristic	All Participants^a (n=33)	Undergraduate Student Body^{a,b,c} (n=33624)
<i>Age (years), mean ± SD</i>	19.5 ± 1.2	20.5 ± NR
<i>College Classification, % (n)</i>		
Freshman	30.3% (10)	20.3% (6837)
Sophomore	27.3% (9)	22.9% (7701)
Junior	27.3% (9)	24.7% (8287)
Senior	15.2% (5)	29.9% (10051)
<i>Race/Ethnicity, % (n)</i>		
White	57.6% (19)	44.8% (15061)
Black/African American	9.1% (3)	5.9% (1973)
Hispanic or Latino/a	9.1% (3)	11.2% (3748)
Asian/Pacific Islander	21.2% (7)	18.0% (6053)
Other/Mixed	3.0% (1)	20.2% (6789)
<i>Gender, % (n)</i>		
Male	30.3% (10)	54.6% (18345)
Female	69.7% (23)	45.4% (15267)
<i>Has Dining Meal Plan, % (n)</i>	51.5% (17)	NR
<i>Residence Type, % (n)</i>		NR
Greek (Fraternity or Sorority) housing	6.1% (2)	
Co-operative or communal housing	3.0% (1)	
Campus residence hall	48.5% (16)	
Off-campus apartment or house	42.4% (14)	
<i>Living Situation, % (n)</i>		NR
Lives alone	6.1% (2)	
Lives with other(s)	93.9% (31)	
<i>Birth Country, % (n)</i>		
United States	90.9% (30)	83.4% (28028)
Other country	9.1% (3)	16.6% (5569)
<i>First-Generation Student, % (n)</i>	24.2% (8)	20.0% (NR)
<i>Sources of Financial Support, % (n)^d</i>		NR
Family	78.8% (26)	
Employment	54.6% (18)	
Government	48.5% (16)	
Scholarship	54.6% (18)	
Loans	48.5% (16)	
Other	3.0% (1)	
<i>Estimated Parental Income, % (n)</i>		NR
Under \$15000	3.0% (1)	
\$15000 to \$34999	9.1% (3)	
\$35000 to \$54999	9.1% (3)	
\$55000 to \$74999	15.2% (5)	
\$75000 to \$99999	21.2% (7)	
\$100000 to \$149999	12.1% (4)	
\$150000 or more	18.2% (6)	
Don't Know	12.1% (4)	
<i>Perceived Familial Social Class, % (n)</i>		NR

Table 5.2 (cont.)

Lower class	9.1% (3)	
Middle class	78.8% (26)	
Upper class	12.1% (4)	
<i>Familial NSLP use, % (n)</i>	27.3% (9)	NR
<i>Familial SNAP use, % (n)</i>	3.0% (1)	NR

NR=Not Reported, NSLP=National School Lunch Program, SNAP=Supplemental Nutrition Assistance Program; ^a Sum of column may not add to 100% due to rounding; ^b Division of Management Information publicly available student enrolment data; Missing data from Division of Management Information: college classification (n=748), gender identity (n=12), and birth country (n=27); ^d Sum of column will be greater than 100% as participants could select more than one source

Figure 5.1. Prevalence of responses to each item of the USDA’s 10-item Adult Food Security Survey Module.



Note. For exact wording of each Food Security Survey Module, refer to Table 5.1.

CHAPTER 6: FUTURE DIRECTIONS

The objective of this work was to understand if current methods for assessing food insecurity (FI), particularly the U.S. Department of Agriculture's (USDA) Food Security Survey Modules (FSSM), were accurately capturing and classifying FI among U.S. college students. The meta-analysis of college FI research indicated that prevalence estimates of FI were influenced by the surveying methods used (Nikolaus, An, Ellison & Nickols-Richardson, 2019a). When various FI assessment protocols were tested in an online survey of undergraduate students, response patterns deviated from expectations and the strongest protocol included a 2-item screener that was not commonly used in the field (Nikolaus, Ellison & Nickols-Richardson, 2019b). When a subset of these students completed the FSSM again, on a paper-and-pencil survey, the number of affirmative responses decreased and resulted in a FI prevalence estimate fifteen percentage points lower than produced from online responses (Nikolaus, Ellison & Nickols-Richardson, 2019c). Finally, cognitive interviews with students detailed underlying interpretations of FSSM items that indicated the questionnaire may have poor content validity in this population, leading to misclassification of some students' FI categorization (Nikolaus, Ellison & Nickols-Richardson, 2019d). In summary, this body of work has revealed several considerable shortcomings of the FSSMs for use with the U.S. undergraduate student population. It is clear that shifts are needed in both practice and research to better address and understand college student FI.

Implications for Practice

Many institutes and organizations have been working to address college FI. Example efforts include traditional food pantries (Twill, Bergdahl & Fensler, 2016; Gupton, Trost &

Collins, 2018; Reppond, Thomas-Brown, Sampson & Price, 2018) as well as meal credit sharing systems (Swipe Out Hunger, 2018). In addition, new initiatives have been recommended, such as greater availability of information to students about federal nutrition assistance programs (Government Accountability Office [GAO], 2018; N.J. Legis. Assemb, 2018). Despite the identified issues with the FSSMs, they remain the best currently available domestic FI surveys for needs assessments, screening students, and evaluating the efficacy of interventions. However, practitioners will need to select the length of the FSSM, inclusion of the 2-item screener, and distribution modality based on 1) the financial resources they have available and 2) the goals of their work. For assessing students that may have any potential FI issues (i.e. low specificity and high sensitivity), the 6-item FSSM distributed online will likely produce the highest FI estimates. In contrast, if resources are limited, to identify students at greatest likelihood of experiencing FI than the 10-item FSSM with the 2-item screener distributed on paper-and-pencil surveys may be appropriate.

Implications for Research

There is a clear need to shift from current efforts that are trying to understand consequences of student FI, the focus of most prior college FI research (Bruening, Argo, Payne-Sturges & Laska, 2017), to instead understanding the manifestation, progression and presentation of FI among students. Some work has begun to provide a glimpse of these processes, with studies using rich qualitative methods (Meza, Altman, Martinez & Leung, 2018; Watson, Malan, Glik, & Martinez, 2018) and longitudinal perspectives (McArthur, Fasczewski, Wartinger & Miller, 2018; Bruening, van Woerden, Todd & Laska, 2018). However, there has been a lack of concerted effort for investigations to stretch beyond the language of USDA FSSMs and pre-

existing domestic FI framework. It is critical that future research moves beyond these existing frameworks.

First, ethnographic investigations would be valuable to understand the lived experience of FI among students. This approach generally “involves the researcher participating, overtly or covertly, in people’s daily lives for an extended period of time” (Hammersley & Atkinson, 2007; p. 3). This approach has been incorporated into investigations of food waste (Evans, 2014), studies of cultural influences on food choices (Freedman, 2016; Kremer-Sadlik, Morgenstern, Peters, Beaupoil, Caët, Debras & Le Mené, 2015), and has broadly influenced dietetics research practices (Ottrey, Jong & Porter, 2018). Though qualitative data was collected on FI experiences among college students (Nikolaus et al., 2019d), the focus of this work was in evaluating the interpretation of the FSSM questions. There is a host of rich details about the manifestation of FI among students that could be better understood by using a variety of ethnographic approaches. Specifically, it would be valuable to compare FSSM responses with observations of students in their everyday patterns of life. This could include observing budgeting activities, meal acquisition and consumption patterns, as well as FI coping behaviors. Pairing these longitudinal observations with documentation of resource availability, both formal and informal, would provide a rich perspective of FI among students. This would be particularly insightful in illustrating how students manage experiences of food and financial shortcomings to 1) understand where institutions may be able to intervene and 2) develop new indicators of FI for surveys.

New FI assessment surveys, or modifications to the FSSMs, will likely need to be developed. Ideally, this would be a product of further ethnographic work but observational research may need to be conducted over several years. In the meantime, surveys will need to be

available for practitioners in the field. Insights from previous cognitive interviews (Nikolaus et al., 2019d) can already serve as a wellspring for possible modifications to the existing FSSMs. For example, adjusting the financial resource to reflect those available to the student (i.e. meal plans or parental support) may produce more accurate responses. In addition, making the financial clause more salient by moving it from the end of many of the FSSM questions to the beginning of each item may deter false affirmations. Other modifications could include providing a wider spectrum of response options and/or replacing the term “balanced meal.” Regardless of the changes enacted, it will be critical that they are tested before widespread use.

Quantitative psychometric investigations to confirm that FI assessment methods are valid (i.e., content, criterion) and reliable (i.e., internal, test-retest) will be important in capturing and quantifying the severity and prevalence of college FI nationally. A natural next step is to investigate the construct validity of the existing recommended protocol (Nikolaus et al., 2019b). Specifically, it would be valuable to evaluate if FI, as assessed by the 10-item FSSM with the 2-item screener, is related to expected sociodemographic risk factors (i.e., no parental financial support, age) as well as expected correlates of FI (i.e. physical health, stress, dietary quality). This would extend the psychometric tests done thus far (Nikolaus et al., 2019b), and inform whether this protocol should be a contender for use across universities in the U.S. However, this testing will need to be performed with students from a variety of institutions.

Delineating the unique experience of FI among university students from those enrolled at community colleges is necessary. Some research has combined community college and university student samples (Nikolaus et al., 2019a), but evidence suggests that community college students are at greater risk of experiencing FI (Blagg, Gundersen, Schanzenbach & Ziliak, 2017). This is likely a byproduct of the underlying differences between student

populations at community colleges and universities. Community college students are more likely to be parents, older, attending part-time, and identify as people of color (Noll, Reichlin & Gault, 2017; Hagedorn, 2010; Kane & Rouse, 1999). It is possible that the FI experienced by community college students and the risk factors of FI differs from that related to university students. Therefore, the presented findings and the proposed studies may receive some consideration for research involving community college students, but distinct studies evaluating the psychometric properties of FI surveys with community college students will be needed.

Significance of Food Insecurity among Students

Though accurately measuring FI among students has been the focus of this work, and arguably of importance for practice and research, it is critical to emphasize and recognize the presence of FI among college students. Regardless of whether it is 10% or 50% of students, evidence is clear that there are students experiencing financial shortcomings and making sacrifices to their food in order to gain a post-secondary education. Though some may argue that college is voluntary and is a large personal expense (Mitchell, Leachman & Masterson, 2016), it is increasingly being viewed as mandatory (Taylor, Fry & Oates, 2014). In line with this sentiment, the population of post-secondary students in the U.S. now includes greater numbers of historically underserved, minority, and low-income students who may not have had access to a higher education in previous decades (Renn & Reason, 2013). As noted in the recent GAO report (2018), the U.S. government, and students themselves, invest substantial financial resources for higher education pursuits. However, when this national, personal, and institutional support does not cover basic needs, including food security, for students then it cannot be expected for these students to perform at their maximum potential in college. For those invested in both the

education of future generations and addressing inequities in U.S. society, acknowledging and addressing college FI is essential.

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APPENDIX A: IRB APPROVAL LETTERS

UNIVERSITY OF ILLINOIS
AT URBANA-CHAMPAIGN

Office of the Vice Chancellor for Research
Office for the Protection of Research Subjects
805 West Pennsylvania Ave
Urbana, IL 61801



September 12, 2017

Brenna Ellison
Agr & Consumer Economics
321 Mumford Hall
1301 W. Gregory Dr.

Urbana, IL 61801

RE: *Prevalence of Food Insecurity among University Students*
IRB Protocol Number: 18087

Dear Dr. Ellison:

This letter authorizes the use of human subjects in your project entitled *Prevalence of Food Insecurity among University Students*. The University of Illinois at Urbana-Champaign Institutional Review Board (IRB) approved, by expedited review, the protocol as described in your IRB application. The expiration date for this protocol, IRB number 18087, is 09/11/2020. The risk designation applied to your project is *no more than minimal risk*.

Copies of the attached date-stamped consent form must be used in obtaining informed consent. If there is a need to revise or alter the consent form, please submit the revised form for IRB review, approval, and date-stamping prior to use.

Under applicable regulations, no changes to procedures involving human subjects may be made without prior IRB review and approval. The regulations also require that you promptly notify the IRB of any problems involving human subjects, including unanticipated side effects, adverse reactions, and any injuries or complications that arise during the project.

You were granted a three-year approval. If there are any changes to the protocol that result in your study becoming ineligible for the extended approval period, the RPI is responsible for immediately notifying the IRB via an amendment. The protocol will be issued a modified expiration date accordingly.

If you have any questions about the IRB process, or if you need assistance at any time, please feel free to contact me at the OPRS office, or visit our website at <https://www.oprs.research.illinois.edu>.

Sincerely,

A handwritten signature in black ink that reads 'Alisa Ortiz'.

Alisa Ortiz, MP
Human Subjects Research Specialist, Office for the Protection of Research Subjects

Attachments: Approved Documents: 1 Research Team Application; 1 Waiver of Documentation of Informed Consent; 1 Consent Form

c: Cassandra Nikolaus
Sharon Nickols-Richardson

UNIVERSITY OF ILLINOIS
AT URBANA-CHAMPAIGN

Office of the Vice Chancellor for Research
Office for the Protection of Research Subjects
805 West Pennsylvania Ave
Urbana, IL 61801



October 10, 2017

Brenna Ellison
Agr & Consumer Economics
321 Mumford Hall
1301 W. Gregory Dr.
Urbana, IL 61801

RE: *Study of Student Food Availability Access Adequacy and Stability*
IRB Protocol Number: 18224

Dear Dr. Ellison:

This letter authorizes the use of human subjects in your project entitled *Study of Student Food Availability Access Adequacy and Stability*. The University of Illinois at Urbana-Champaign Institutional Review Board (IRB) approved, by expedited review, the protocol as described in your IRB application. The expiration date for this protocol, IRB number 18224, is 10/09/2020. The risk designation applied to your project is *no more than minimal risk*.

Copies of the attached date-stamped consent form(s) must be used in obtaining informed consent. If there is a need to revise or alter the consent form(s), please submit the revised form(s) for IRB review, approval, and date-stamping prior to use.

Under applicable regulations, no changes to procedures involving human subjects may be made without prior IRB review and approval. The regulations also require that you promptly notify the IRB of any problems involving human subjects, including unanticipated side effects, adverse reactions, and any injuries or complications that arise during the project.

You were granted a three-year approval. If there are any changes to the protocol that result in your study becoming ineligible for the extended approval period, the RPI is responsible for immediately notifying the IRB via an amendment. The protocol will be issued a modified expiration date accordingly.

If you have any questions about the IRB process, or if you need assistance at any time, please feel free to contact me at the OPRS office, or visit our website at <https://www.oprs.research.illinois.edu>.

Sincerely,

A handwritten signature in blue ink that reads "A. V. Ortiz" with a stylized flourish at the end.

Alisa Ortiz, MP

Human Subjects Research Specialist, Office for the Protection of Research Subjects

Attachment(s): 1 Research Team Application, 2 Consent Forms

c: Cassandra Nikolaus
Sharon Nickols-Richardson



OFFICE OF THE VICE CHANCELLOR FOR RESEARCH

Office for the Protection of Research Subjects
805 W. Pennsylvania Ave., MC-095
Urbana, IL 61801-4822

Notice of Approval: New Submission

February 12, 2019

Principal Investigator	Brenna Ellison
CC	Cassandra Nikolaus; Sharon Nickols-Richardson
Protocol Title	<i>College Students' Food Behaviors and Lifestyle</i>
Protocol Number	19452
Funding Source	Unfunded
Review Type	Expedited 4, 7
Status	Active
Risk Determination	no more than minimal risk
Approval Date	February 12, 2019
Closure Date	February 11, 2024

This letter authorizes the use of human subjects in the above protocol. The University of Illinois at Urbana-Champaign Institutional Review Board (IRB) has reviewed and approved the research study as described.

The Principal Investigator of this study is responsible for:

- Conducting research in a manner consistent with the requirements of the University and federal regulations found at 45 CFR 46.
- Using the approved consent documents, with the footer, from this approved package.
- Requesting approval from the IRB prior to implementing modifications.
- Notifying OPRS of any problems involving human subjects, including unanticipated events, participant complaints, or protocol deviations.
- Notifying OPRS of the completion of the study.

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

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