



Prevalence of Food Insecurity in the General College Population and Student-Athletes: a Review of the Literature

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Abstract

Purpose of Review The purpose of this review is to examine the prevalence of food insecurity (FI) among the general college student population with a focus on student-athletes and the impact of the COVID-19 pandemic on FI in these groups.

Recent Findings FI is estimated to be more prevalent in college students than in the general population, although ranges vary widely. Less is known about FI among college student-athletes. Data on changes in FI prevalence pre-pandemic and during is mixed.

Summary Colleges and universities should invest in interventions to address FI on their campuses, and further research on FI among student-athletes and the impact of the COVID-19 pandemic on FI is needed.

Keywords Food insecurity · Food security · College student · Athlete · Hunger · COVID-19

Introduction

Food insecurity (FI) is the lack of consistent access to safe and healthy food [1]. In 2020, the prevalence of FI among households in the US was estimated to be 10.5%, which was down from 11.1% in 2019 [2]. Comprehensive national data since the start of the COVID-19 pandemic are not yet available, but local data indicate that the prevalence of FI has increased, particularly among the newly food insecure as a result of COVID-19 [3]. Among the US population,

pre-COVID-19 rates of FI among college students range from 10 to 75% [4].

While the general college population has been widely studied, less is known about the prevalence of FI among collegiate athletes. One non-peer-reviewed source on this topic is the RealCollege survey of students at 4-year and 2-year institutions in the US conducted by the Hope Center for College, Community, and Justice [5]. The most recent survey in fall 2019 aggregated data for student-athletes for the first time. “Student-athlete” was self-reported as participating in their institution’s athletic department. Of the almost 167,000 total students who completed the survey, 1866 were student-athletes at 4-year institutions and 1640 attended 2-year institutions. Prevalence of FI among athletes at 4-year institutions and 2-year institutions was 23% and 39%, respectively. For non-athletes, these rates were 32% and 43%, respectively. This report, as well as the ripple effects from the pandemic, have spurred increased interest on the topic of FI among college students in general and student-athletes specifically. The purpose of this review is to examine the prevalence of FI among the general college student population and student-athletes, also taking into consideration the impact of the COVID-19 pandemic on FI in college students.

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Search Strategy and Selection Criteria

After conducting preliminary searches to identify key words, a systematic search of PubMed, SportDiscus, and Medline (using EBSCOhost Research Platform) was conducted, and all were screened for original, primary research articles published in the last 5 years since 2016. The search strategy was based on sensitivity and did not include terms related to comparators or outcomes in order to allow for the potential retrieval of a larger number of articles. The following search terms were used to search the databases with filters for human subject research and English language applied without restriction on study design: “food insecurity” and “food security” in combination with “college” or “athlete.”

A defined set of eligibility criteria was constructed with the following inclusion criteria: a population of college students in the US, use of a validated tool for food security (FS), results that included a reported overall prevalence of FI, clear methodology that could confirm all inclusion criteria, and the article written in English. Exclusion criteria included not meeting the previous inclusion criteria and/or ambiguous methods that could not confirm all inclusion criteria.

Data were extracted independently by three researchers and included study objective, sample size, and population characteristics (gender, race/ethnicity, 4-year or 2-year institution, non-athlete or athlete status, undergraduate or graduate status, first-generation college student, assessment tool utilized, time frame of assessment, study design, and results and outcomes). The results and outcomes data from each of the studies included an overall % FI, % low and very low FS when available, and factors associated with FI. Full data can be found in Tables 1 and 2.

Results and Discussion

Searches of the databases resulted in a total of 801 studies. After screening of the titles and abstracts and excluding review articles and duplicates, 62 articles remained. After a more careful screening of the full texts, 16 were excluded for not meeting the inclusion criteria. One additional publication became available during the preparation of this manuscript and was subsequently included in the data and discussion. Therefore, a total of 47 articles that met the inclusion criteria were analyzed and evaluated [6–9, 10••, 11–17, 18•, 19, 20•, 21•, 22•, 23–28, 29•, 30–37, 38••, 39–52] (see Table 1).

Study Characteristics

Of the 47 studies, 44 were cross-sectional research [6–9, 10••, 11, 15–17, 18•, 19, 20•, 21•, 22•, 23–28, 29•, 30–37, 38••, 39–52] and three were cohort design [12, 13, 44]. Two

of the studies were performed at 2-year institutions [25, 46] with the other 45 at 4-year institutions [6–9, 10••, 11–17, 18•, 19, 20•, 21•, 22•, 23, 24, 26–28, 29•, 30–37, 38••, 45, 47–52]. All but two of the studies were focused on the general college student population (non-athletes) while the other two were focused on student-athletes [10••, 38••]. For the administration of the assessment tools, in 41 studies an online version was utilized [6, 8, 10••, 11–17, 18•, 19, 20•, 21•, 22•, 23–28, 29•, 30–37, 39–45, 49–52], a paper version in two studies [9, 38••], and both in one study [7]. There were three studies where the mode of administration was not stated [46–48]. In all but three studies [13, 17, 25] some version of the USDA Economic Research Service’s survey tool was used to assess FS [53]. The USDA has three validated surveys that categorize FS levels: the 18-item Household Food Security Survey Module (HFSSM), the 10-item Adult Food Security Survey Module (AFSSM), and the 6-item AFSSM Short Form. Within the HFSSM, there are specific questions about FS status of children in the household, while these questions are omitted from the other two surveys. In the majority of the assessments, participants were queried about FS in the past 12 months [6–9, 10••, 12, 14, 15, 17, 18•, 19, 20•, 21•, 22•, 23, 24, 26–28, 29•, 30–34, 37, 39–43, 45, 46, 52]. In one, FS status was assessed over the past 9 months [35], and in the remaining studies, FS status was assessed over the past 30 days [11, 16, 36, 47–51]. No time frame was specified in four studies [13, 25, 38••, 44]. FS status was reported on a continuum from high FS to very low FS. A person is considered to have FI if they have “low” or “very low” FS.

Food Insecurity Among the General College Student Population

The overall prevalence of FI from all subjects combined in this current review reveals a much higher prevalence of FI in college students at $32.2 \pm 12.9\%$ (range 9.9–72.9%) compared to the national household average in the USA in 2019 (10.5%) [2]. The overall prevalence was obtained by the sum of all published prevalences from each of the studies included in the review, divided by the total of studies included in the review, and then multiplied by 100 to yield a percent. Breaking down the results from the current review, the prevalence of FI at 4-year institutions and 2-year institutions was $32.7 \pm 12.9\%$ (range 9.9–72.9%) and $37.8 \pm 20.1\%$ (23.36–52%), respectively. These are in line with the results from the Hope Center survey (32% from 4-year institutions and 43% from 2-year institutions) [5]. When comparing the results based on the assessment tool, it appears that the 6-item ($35.3 \pm 11.7\%$; range 9.9–48.0%), 10-item ($30.3 \pm 10.1\%$; range 9.9–48.0%), and 18-item ($33.8 \pm 18.5\%$; range 15.0–52.0%) surveys all yielded similar results while

Table 1 Summary of research studies on food insecurity in college students

Reference	Study Objective	Population	Assessment	Results
Adamovic et al. [6]	Determine prevalence of FI among students, variables associated with FI, and possible solutions	<i>n</i> = 339 students (70% female) at a large public university in the western USA	Online survey including USDA 6-Item AFSSM Short Form (Dec 2016–Feb 2017), demographic questions, and question about possible solutions	54% FI in the last year (26% low FS; 28% very low FS) Students receiving financial aid that required repayment more likely to be FI (<i>p</i> < 0.001) Proposed solutions included on- and off-campus food assistance and education initiatives
Ames et al. [7]	Evaluate the USDA Adult Food Security Survey Module for use with US college students	<i>n</i> = 478 students (51.1% Caucasian) at a public university in the Southern USA	Online and in-person survey including USDA 10-item AFSSM	21.3% FI in the last year (9.6% low FS; 11.7% very low FS) Authors conclude that the 10-item survey, particularly questions on household food security, may lead to inaccurate results in college students
Barry et al. [8]	Relationship between FI and screening positive for an eating disorder	<i>n</i> = 804 students (50% female) at a large, public university in the Midwestern US; oversampling from racial/ethnic minorities, 1st-generation college students, and students from low SES households	Online survey including USDA 10-item AFSSM and 5-item SCOFF questionnaire	35.1% FI in the last year (16.3% low FS; 18.8% very low FS) Males (37.5%) had higher prevalence of FI than females 29.0% screened positive for an eating disorder Positive SCOFF screen associated with marginal food security (PR = 1.83; <i>p</i> = 0.001), low FS (PR = 1.72; <i>p</i> = 0.007), and very low FS (PR = 2.83; <i>p</i> < 0.0001)
Becerra et al. [9]	Assess the role of FI and other social determinants on mental health of college students	<i>n</i> = 302 undergrad students (63.0% female) from a mid-sized, public institution in the USA; majority Hispanic (67.9%) and 1st-generation commuters	Hard copy survey including USDA 6-Item AFSSM Short Form, questions measuring self-perceived mental health status and psychological distress (Kessler-6 scale), and other demographic questions	37.5% FI in the last year Among FI, higher odds of reported psychological distress (OR = 3.645, <i>p</i> < 0.05) and average to very poor self-perceived mental health status (OR = 2.687, <i>p</i> < 0.05) compared to FS
Brown et al. (in press) [10••]	Prevalence of FI in NCAA D3 athletes	<i>n</i> = 787 NCAA D3 collegiate athletes (64.4% female; 81.5% white) from schools across the USA representing 19 sports	Online descriptive survey including 5 questions from the USDA 6-Item AFSSM Short Form (Jan–Feb 2020), 17 questions about FI in the context of college athletics, and demographic questions	14.7% were FI in the last year FI among self-identified white (13.3%), Hispanic (18.3%), Black (31.0%), and Asian (8.5%) FI for those with/without a meal plan (11.5% vs. 29.9%), Pell grant (11.1% vs. 26.5%), 1st-generation college (11.3% vs. 27.2%), and previous experience of FI (11.5% vs. 52.5%) Self-reported negative impact of FI on academic and athletic performance

Table 1 (continued)

Reference	Study Objective	Population	Assessment	Results
Bruening et al. [11]	Prevalence of FI and associations with health outcomes among 1st-year college students	<i>n</i> = 209 1st-year students (62% female) attending a large university in the Southwestern USA living on campus	128-item online survey including FI questions adapted from USDA 18-Item HFSSM and 2-item Hunger Vital Sign Tool; and questions on demographics, dietary, and physical activity behaviors, and social-environmental health	32% reported inconsistent food access in the past month and 37% in the past 3 months Students with FI had higher odds of depression compared to non-FI (OR = 2.97; 95% CI = 1.58, 5.60) Students with FI had lower odds of eating breakfast, consuming home-cooked meals, perceiving their off-campus eating habits as healthy, and receiving food from parents (<i>p</i> < 0.05)
Bruening et al. [12]	Associations between FI and health behaviors and outcomes among 1st-year college students	<i>n</i> = 1118 1st-year students (65% female; 51% white) in SPARC study at a large university in the Southwestern USA living on campus	Online survey (2015–2016) including USDA 6-Item AFSSM Short Form modified to ask about FI in the past 1 month; 26-item DSQ to assess eating behaviors; questions about alcohol intake; Godin-Shepard PA assessment; questions about mental health and depression; and demographics	FI higher at the end of each semester (35% in fall, 36% in spring) compared to baseline at the beginning of the year (28%) FI not related to any health behaviors/outcomes at future time points compared to baseline FI inversely associated with concurrent breakfast consumption (OR = 0.67, 99% CI = 0.46, 0.99), daily evening meal consumption (OR = 0.55, 99% CI = 0.36, 0.86), healthy eating habits on campus (OR = 0.68, 99% CI = 0.46, 1.00), and healthy physical activity habits on campus (OR = 0.66, 99% CI = 0.44, 1.00) FI positively related to likelihood of expressing stress (OR = 1.69, 99% CI = 1.16, 2.46) and depressed mood (OR = 1.98, 99% CI = 1.34, 2.91)
Christensen et al. [13]	Association between FI and eating disorder pathology among college students before and during the beginning of the COVID-19 pandemic	<i>n</i> = 579 students (76.3% female; 84.1% white) from a large university in the Midwestern USA	Online survey including 8-item Radimer/Cornell FI measure; Clinical Impairment Assessment; Eating Disorder Diagnostic Scale 5; and demographics sent to two samples (Dec. 9, 2019–Mar. 5, 2020 and Apr. 13–27, 2020)	52.8% FI Hispanics more likely to report FI than non-Hispanics and Blacks more likely to report FI than other racial groups No difference in FI before or during the beginning of the COVID-19 pandemic Greater frequency of eating disorder pathology among students with FI compared to non-FI, specifically higher prevalence of eating disorder diagnoses (47.6% vs. 31.1%, <i>p</i> < 0.01, NNT = 6.06)

Table 1 (continued)

Reference	Study Objective	Population	Assessment	Results
Cockerham et al. [14]	Prevalence of FI and relationship to social support, GPA, financial resources, and 1st-generation college status among nursing students	<i>n</i> = 55 full-time undergrad nursing students (87.3% female; 41.8% 1st-generation) at a public university in the USA	Online survey including USDA 6-Item AFSSM Short Form; 12-item MSPSS; and questions related to finances, academics, and demographics	60% FI in the last year (34.5% very low FS) Higher FI among 1st-generation students ($p < 0.01$) Low FI correlated with less social support ($p < 0.01$) FI had lower GPAs ($p < 0.05$)
Cuy et al. [15]	Prevalence of FI among college students considering students' financial prioritization and nutrition literacy	<i>n</i> = 560 undergrad and graduate students (78% non-Hispanic white) at a mid-sized private Catholic university in the USA	Online survey including USDA 6-Item AFSSM Short Form; New Vital Signs Food Label Instrument; and demographic questions	36.7% FI in the last year (25.4% low FS; 11.3% very low FS) Significant correlation between FS and nutrition literacy ($\chi^2 = 13.9, p = 0.001$)
Davitt et al. [16]	Prevalence of FI during the beginning of the COVID-19 pandemic	<i>n</i> = 1434 undergrad and graduate students (61% female; 82% non-Hispanic white) at a large Midwestern public university in the USA	Online survey including USDA 6-Item AFSSM Short Form; 10-item food screener; questions about eating and cooking habits; and demographic questions (Apr 26–30, 2020)	17% FI in the last 30 days Factors related to FI were non-white ethnicity, living on their own, same living situation as before campus closure, undergrad status, international status, being married, receiving financial aid, having higher BMIs, self-reported poorer health status, lower cooking self-efficacy, stress, and more take-out or fast food consumption
Duke et al. [17]	Prevalence of FI among HBCU students	<i>n</i> = 351 undergrad and graduate students (80.6% female; 91.2% non-Hispanic Black/African American) at 4 HBCUs in the Southeastern USA	Online survey including: 2-item Hunger Vital Sign Tool and demographics	72.9% FI in the last year Similar rates of FI regardless of meal plan status Compared to first-year students, seniors were more likely to worry that food would run out before getting enough money to buy more ($p < 0.01$)
El Zein et al. [18•]	Relationship between FI and food pantry awareness, use, and perceived barriers to use	<i>n</i> = 899 undergrad and grad students (74.3% female; 77.6% white) at large university in Southeastern USA	Online survey (Oct 2017) including USDA 10-item AFSSM; questions about food pantry awareness; and demographics	32% FI in the last year (15.4% low FS; 16.1% very low FS) FI more prevalent among the following groups: international students (37.6%, $p = 0.006$), undergrads (34%, $p = 0.01$), Black students (61.7%, $p < 0.0001$), and Pell grant recipients (50.2%, $p < 0.0001$) 70% of students are aware of food pantry; 38.5% of FI students used the food pantry; 36.4% of students who use the pantry use it as their sole source of food

Table 1 (continued)

Reference	Study Objective	Population	Assessment	Results
El Zein et al. [19]	Prevalence of FI and sociodemographic, health, academic, and food pantry correlates among 1st-year college students	$n = 855$ 1st-year students (68.8% female; 62.4% non-Hispanic white) from 8 universities in the USA participating in the <i>Get FRUVED</i> study	Online survey including USDA 10-item AFSSM; Pittsburg Sleep Quality Index; Cohen's Perceived Stress Scale; EAT-26; and questions about food pantry awareness and sociodemographics In-person anthropometrics collected (Fall 2015–Spring 2016)	19% FI in the last year (12% low FS; 7% very low FS) FI more prevalent among racial minorities, specifically Black or Hispanic/Latino ($p < 0.001$); off-campus students ($p = 0.001$); Pell grant recipients ($p < 0.001$); parental education of high school or less ($p < 0.001$); and students with no meal plan ($p = 0.001$) FI at higher risk for poor sleep quality (OR = 2.32, 95% CI: 1.43, 3.76), high stress (OR = 4.65, 95% CI: 2.66, 8.11), disordered eating behaviors (OR = 2.49, 95% CI: 1.20, 4.90), and GPA < 3.0 (OR = 1.91, 95% CI: 1.19, 3.07) 56.4% of students are aware of food pantry; 22.2% of students with FI endorsed using food pantry
El Zein et al. [20]	Sex-specific associations between FI and obesity among college students	$n = 683$ 2nd-year students (69.2% female; 47.8% non-Hispanic white) from 8 universities in the USA participating in the <i>Get FRUVED</i> study	Online survey including USDA 10-item AFSSM; NCI 26-item Dietary Screener Questionnaire; and sociodemographics In-person anthropometrics (April 2017)	25.4% FI in the last year (14.3% low FS; 11.1% very low FS) FI associated with increased odds of obesity compared to high FS: marginal food security 3.16 (95% CI: 1.55, 6.46) and FI 5.13 (95% CI: 2.63, 10.00) Students with FI had lower intake of fruits and vegetables and higher intake of added sugars and obesity ($p = 0.001$) than students who were FS Students with FI and meal plans had higher rates of obesity and added sugar intake ($p < 0.001$) than FI students with meal plans

Table 1 (continued)

Reference	Study Objective	Population	Assessment	Results
Hagedorn et al. [21]	Determine the association between FI status and money expenditures, coping strategies, and academic performance among a regional sample of college students	<i>n</i> = 13,642 students (76.1% female; 75.1% white) at 10 public universities	73-item online survey including USDA 10-item AFSSM; 8-item money expenditure scale (MES); 29-item coping strategies scale (CSS); 4-item academic progress scale (APS); and socioeconomic and health characteristics	30.5% FI in the last year (range among schools 22.4–51.8%) MES (OR = 1.47; 95% CI: 1.40, 1.55), CSS (OR = 1.19; 95% CI: 1.18, 1.21), and APS (OR = 0.95; 95% CI: 0.91, 0.99) scores remained significant predictors of FI GPA, academic year, health, race/ethnicity, financial aid, cooking frequency, and health insurance remained significant predictors of FS FI students were more likely to display high money expenditures and coping mechanisms
Hagedorn et al. [22]	Assess relationship between FI, sleep quality, and days with mental and physical health issues among college students	<i>n</i> = 17,686 students (74.8% female; 83.5% white) enrolled at one of 22 participating universities	122-question online survey including USDA 10-item AFSSM; 19-item PSQI; and 3 items from Healthy Days Core Module	43.4% FI in the last year FI had higher PSQI scores indicating poorer sleep quality (<i>p</i> < 0.0001) FI reported more days with poor mental (<i>p</i> < 0.0001) and physical (<i>p</i> < 0.0001) health as well as days when mental and physical health prevented them from completing daily activities (<i>p</i> < 0.0001) FI had higher adjusted odds of having poor sleep quality (AOR: 1.13; 95% CI 1.12, 1.14), days with poor physical health (AOR: 1.01; 95% CI 1.01, 1.02), days with poor mental health (AOR: 1.03; 95% CI 1.02, 1.03), and days when poor mental or physical health prevented them from completing daily activities (AOR: 1.03; 95% CI 1.02, 1.04)
Keogh et al. [23]	Investigate whether peer support and demographic characteristics predicted food security among deaf college students	<i>n</i> = 166 college students who are deaf (52% women; 54% people of color)	Bilingual online survey including USDA 6-item AFSSM; 3 health-related items from HINTS-ASL; and questions about peer support and socioeconomics	38.3% FI in the last year (26.4% low FS; 12.9% very low FS) Compared to people who reported always receiving peer support, those who never received peer support were 16.3 × more likely to experience FI (AOR = 16.325, 95% CI: 1.8, 146.1)

Table 1 (continued)

Reference	Study Objective	Population	Assessment	Results
Knol et al. [24]	Investigate relationships between FI status and cooking self-efficacy and food preparation behaviors among college students	<i>n</i> = 368 undergrad students (70.4% female; 83.4% non-Hispanic white) living off campus at Univ of Alabama	Online survey including USDA 10-item AFSSM; and questions about cooking self-efficacy, food preparation behaviors, food security status, financial resources, and demographics	38.3% FI in the last year FI had higher cooking self-efficacy than participants who had low ($p = 0.02$) and very low FS ($p = 0.001$) Very low FI reported engaging in food preparation behaviors less often than FS ($p = 0.001$), marginally FS ($p = 0.005$), and low FS ($p = 0.03$) Females and participants with < \$1000 of financial aid debt reported engaging in food preparation behaviors more often than males ($p < 0.001$) and those with \geq \$10,000 financial aid debt ($p = 0.02$)
Laska et al. [25]	Assess sociodemographic and health disparities among 2- and 4-year post-secondary students screening positive for FI, using one of the largest relevant health surveillance databases available	<i>n</i> = 13,720 students (66% female; 77% non-Hispanic white) participating in state-based surveillance of 27 2-year and 4-year Minnesota post-secondary institutions (pooled data 2015–2018)	Online survey including 2-item Hunger Vital Sign Tool; BMI; YRBS items; and demographic, personal, and economic factors	23.6% screened positive for FI Observed disparities in positive FI screens by gender, racial/ethnic categorization, parent education, and level in school ($p < 0.05$) FI were more likely than FS to have BMI \geq 30, less physical activity, and more SSB, breakfast skipping, and fast food compared to FS ($p < 0.001$) FI were more likely than FS to use tobacco and marijuana and to binge drink FI were less likely to have had a recent routine medical exam and more likely to have diagnosed depression, poor mental health, more stress, and insufficient sleep FI reported having less supportive relationships, lower perceived resiliency, and lower GPAs than FS

Table 1 (continued)

Reference	Study Objective	Population	Assessment	Results
Leung et al. [26]	Examine differences in dietary intake, food and cooking agency, and BMI by FS status	<i>n</i> = 754 college students (52.3% female; 71.6% non-white) at a large, public Midwestern university	Online survey including USDA 10-item AFSSM; NCI 26-item Dietary Screener Questionnaire; CAFPAS (cooking agency); and BMI	31.1% FI in the last year (15.8% low FS; 15.3% very low FS) FI was higher among females; non-Hispanic Black, Hispanic, and other race/ethnicity or multiracial students; 1st-generation college, and financial aid recipients BMI for very low FI was 2.6 higher (SE ± 0.5; <i>p</i> < 0.001) than FS Low and very low FS were also associated with lower CAFPAS scores
Leung et al. [27]	Examine cumulative burden of food, financial, and housing insecurities on college students' health and academic performance	<i>n</i> = 793 college students (50% female; 43% non-white) at a large, public Midwestern university	Online survey including USDA 10-item AFSSM; Community College Survey of Student Engagement (financial health); 2-item housing insecurity screener; Patient Health Questionnaire-4 (anxiety and depression); and questions about general health, GPA, and demographics	33.6% FI, 40.3% housing insecure, and 17.4% financially insecure in the last year The correlations between the basic needs insecurities were food and FI (0.69), food and housing insecurity (0.60), and financial and housing insecurity (0.58) Students experiencing FI, financial insecurity, or housing insecurity were more likely to have anxiety and/or depression, fair/poor health, and lower mean GPA than FS counterparts
Marshall et al. [28]	Describe prevalence of FI, food access behaviors, and associations between FS status and well-being in a dental student population	<i>n</i> = 81 students (60% female; 81.5% white) enrolled in the College of Dentistry at the University of Iowa in the fall 2019	Online survey including USDA 10-item AFSSM; food- and hunger-related well-being (i.e., sleep, academic performance, and stress)	21% FI in the last year (9.9% low FS; 11.1% very low FS) FI more likely to: Rely on financial aid and military scholarships than family support or savings (57.9% vs. 20.8%; <i>p</i> = 0.002) Take out ≥ \$70,000 in loans each year (62.5% vs. 36.4%; <i>p</i> = 0.024) and use the financial aid to cover living expenses (58.8% vs. 26.7%; <i>p</i> = 0.005) Attend collegiate programming with a primary purpose of obtaining a free meal to stretch their food dollars than their FS peers (68.4% vs. 27.9%; <i>p</i> < 0.001) Report study or academic performance concerns (51.6% vs. 21.3%; <i>p</i> = 0.005) and stress-related food or hunger concerns (48.4% vs. 17%; <i>p</i> = 0.003)

Table 1 (continued)

Reference	Study Objective	Population	Assessment	Results
Martinez et al. [29•]	Examine the simultaneous relationships between FI and health-related outcomes	<i>n</i> = 8705 undergrad and grad students (67% female; 66% non-white) from all 10 University of California campuses	Online survey including USDA 6-item AFSSM; and questions about diet quality (daily servings of FV), sleep sufficiency, physical activity, and BMI	40% FI in the last year Higher percentages of FI were overweight/obese (33%) than FS (25%) FI related to fewer: Days of enough sleep, which was related to increased BMI and poor health Days of mod. to vigorous physical activity, which was related to increased BMI and poor health Daily servings of FV, which was related to poor health
McArthur et al. [30]	Measure prevalence and correlates of FI among college students in Appalachia, compare FI and FS students on correlates, and identify predictor variables	<i>n</i> = 1093 students (68.4% female; 91.7% non-Hispanic white) at a university in Appalachia	73-item online survey including USDA 10-item AFSSM; 8-item money expenditure scale; 29-item coping strategies scale; 4-item academic progress scale; 4 questions from the NHANES Social Support Scale; BMI/anthropometric variables; and demographic questions	46.2% FI in the last year (21.9% low FS; 24.3% very low FS) Predictor variables were higher money expenditure and coping strategy scale scores, lower GPAs, male gender, receiving financial aid, fair or poor self-rated health status, and never cooking Most frequently used coping strategies included purchasing low-cost, processed food (57.4%), stretching food (40.5%), and eating less healthy meals to eat more (35.4%)
McArthur et al. [31]	Examine family and campus FI among freshmen at a university in Appalachia	<i>n</i> = 456 freshmen, (73% female; 82.5% non-Hispanic white) at a university in Appalachia	Online survey including USDA 10-item AFSSM; Meal Skipping Scale; items rating eating habits and sources of social support for accessing food on campus; Academic Progress Scale; and anthropometric, economic, and demographic questions	28.6% FI in the last year (7.1% low FS; 21.5% very low FS) 42.5% of those who experienced campus FI believed their food access had worsened since starting college Coping strategies of FI compared to FS included stretching food (72.9% vs. 18.4%) and purchasing low-cost, processed food (68.8% vs. 16.3%) FS scored higher on self-rated measures of academic progress ($p < 0.01$) More FS compared to FI perceived their eating habits since starting college as “healthy/very healthy” (60.7% vs. 43.9%, $p < 0.01$) and perceived their health status as “good/excellent” (86.0% vs. 71.4%, $p < 0.01$) FI requested assistance with job opportunities (19.4%), affordable meal plans (18.4%), money management (13.3%), and eating healthy (11.2%)

Table 1 (continued)

Reference	Study Objective	Population	Assessment	Results
Mei et al. [32]	Examine association between FI and dietary intake in a sample of undergrad students with unlimited meal plans and dining hall access	<i>n</i> = 1033 undergrad students (48% female; 55% non-Hispanic white) at a large, public Midwestern university	Online survey including USDA 6-item AFSSM; NCI 26-item Dietary Screener Questionnaire; Beverage Intake Questionnaire-15; and demographic and socioeconomic questions	14% FI in the last year FI reported lower intakes of fruits (9%, <i>p</i> = 0.02), vegetables (9%, <i>p</i> < 0.001), and fiber (4%, <i>p</i> = 0.01), and higher intakes of dairy (10%, <i>p</i> = 0.002), total added sugars (6%, <i>p</i> = 0.01), added sugars from SSB (10% <i>p</i> = 0.01), and calcium (4%, <i>p</i> = 0.01), compared to FS FI had 56% higher intake of total sugar-sweetened beverages (<i>p</i> = 0.002), which was driven by 185% higher intake of energy and sports drinks (<i>p</i> = 0.001), and 121% higher intake of sweetened teas (<i>p</i> = 0.001) compared to FS
Mialki et al. [33]	Identify and describe the prevalence of FI at a public university before and after the onset of COVID-19 as well as factors associated with any change in FS	<i>n</i> = 3206 students (70.7% female; 72.9% white) at a large, public land grant university	Online survey including USDA 10-item AFSSM and sociodemographic questions	Pre-COVID: 24.8% FI in the last year (12.2% low FS; 12.6% very low FS) FS associated with gender (<i>p</i> = 0.007), race (<i>p</i> < 0.001), and ethnicity (<i>p</i> < 0.001) FI higher in Hispanic/Latino than non; FI higher in Black/African American than white or Asian Change: 38% of all students experienced a change in FS as a result of the pandemic (59.6% became less FS and 40.4% became more FS)
Mirabitur et al. [34]	Assess prevalence of FI among students and potential associations with various student characteristics	<i>n</i> = 514 students (72.2% female; 65.6% white) at a large, Midwestern, public university	Online survey including USDA 6-item AFSSM; validated 2-item measure to report daily FV servings; and demographic questions	41.5% FI in the last year (25.1% low FS; 16.4% very low FS) among those in housing without food provision Factors associated with a higher likelihood of FI were self-reporting as underrepresented minorities (95% CI: 1.56, 4.73; <i>p</i> < 0.001), no car access (95% CI: 1.09, 4.59; <i>p</i> = 0.03), and undergrad status (95% CI: 0.18, 0.56; <i>p</i> < 0.001) Low FS was associated with less daily servings of FV (<i>p</i> = 0.01)

Table 1 (continued)

Reference	Study Objective	Population	Assessment	Results
Morris et al. [35]	Determine prevalence of FI among students and potential associations of various sociodemographic characteristics	<i>n</i> = 1882 undergrad students (66.6% female; 77.4% white) at 4 Illinois universities	Online survey including USDA 10-item AFSSM and sociodemographic questions	35.0% FI in the past nine months (16.6% low FS; 18.4% very low FS) Significant relationships between FS status and race, GPA, loan use, and living location
Owens et al. [36]	Determine prevalence of FI among students during COVID-19	<i>n</i> = 502 undergrad and grad students (93.6% female; 50.4% white) at a Texas University	Online survey including USDA 6-item AFSSM; validated 2-item Food Sufficiency Screener; and sociodemographic questions	34.5% FI in the past month (20.2% low FS; 14.3% very low FS) 65.5% of students at risk for FI; among those, prevalence of FI was 52.7% (30.8% low FS; 1.9% very low FS) Factors associated with increased prevalence of FI were undergrad status, self-reporting as a minority student, single parents, students taking classes on the Denton campus ($p < 0.001$), younger students ($p = 0.02$), and overweight/obese ($p < 0.001$) FI more likely among those that had their living situation ($p < 0.001$) or employment/income ($p < 0.001$) impacted by COVID-19
Payne-Sturges et al. [37]	Assess prevalence of FI among students, examine potential associations of various sociodemographic characteristics, and identify potential risk factors	<i>n</i> = 237 undergrad students (81.0% female; 49.0% white) at a large, public mid-Atlantic University	Online survey including USDA 18-item HFSSM and sociodemographic questions	15% FI in the last year (6.5% very low FS) Factors associated with an increased prevalence of FI were housing instability, receiving multiple forms of financial aid, and self-reporting as a minority student
Poll et al. [38••]	Determine the relationship between FI and current disordered food consumption behavior	<i>n</i> = 111 NCAA Division I student-athletes (100% male; 56.8% white)	Hard copy survey of USDA 10-item AFSSM and food consumption behavior questions	3.5% FI when they were in high school and 9.9% assessed as FI in college High school FI status was associated with preoccupation with food in college ($r = 0.279$, $p < 0.001$) Collegiate FI status was significantly associated with preoccupation with food [$r = 0.336$, $p < 0.001$] and keeping food or hiding food [$r = -0.272$, $p < 0.0003$]

Table 1 (continued)

Reference	Study Objective	Population	Assessment	Results
Raskind et al. [39]	Determine the impact of psychosocial health on the relationship between FI and GPA	<i>n</i> = 2377 college students (64.2% female; 61.9% white) from 7 colleges/universities in Georgia	Online survey including USDA 6-item AFSSM; psychosocial health information; and GPA data	29% FI in the last year Poor psychosocial health was associated with FI (<i>p</i> < 0.0001) and FI was associated with lower GPA (<i>p</i> < 0.0001) The majority of the impact of FI on GPA could be accounted for by psychosocial health
Reeder et al. [40]	Assess the prevalence of FI and determine any associations with depression and race	<i>n</i> = 131 college students (72.5% female; 71.0% white) from a large, public university in Mississippi	Online survey including USDA 6-item AFSSM; PHQ-9; and sociodemographic questions	38.2% FI in the last year (24% low FS; 13.7% very low) African American students more likely to be FI than Caucasian students (OR = 3.50, 95% CI: 1.38, 8.90) Students classified as very low FS were 4.52 × more likely to experience depression than those that were classified as FS (<i>p</i> = 0.011, 95% CI: 1.42, 14.36)
Sackey et al. [41]	Assess the prevalence of FI and determine associated factors	<i>n</i> = 302 health science graduate students (77.5% female; 53.7% white) at a large, urban, university in the Northeast	Online survey including USDA 6-item AFSSM and sociodemographic questions	28.5% FI in the last year Receiving multiple school loans (<i>p</i> < 0.001), annual income of < \$25,000 (<i>p</i> = 0.006), annual income of \$25,000–\$34,999 (<i>p</i> = 0.02), female sex (<i>p</i> = 0.04), being a 1st-generation college student (<i>p</i> = 0.04), and use of food pantries (<i>p</i> < 0.001) were associated with being FI

Table 1 (continued)

Reference	Study Objective	Population	Assessment	Results
Smith et al. [42]	Assess the prevalence of FI and determine any associations between FI and carotenoid levels and coping strategies	$n = 355$ students from a mid-size 4-year university	Online survey included USDA 10-item AFSSM; BioPhotonic Scanner™; assessments for coping strategies and hunger levels; and sociodemographic questions	31.7% FI in the last year (26.6% low FS; 5.1% very low FS) Factors associated with FI were ethnicity (OR = 0.191, 95% CI: 0.040, 0.918; $p = 0.039$), avoidance of spending money on more expensive foods such as FV (OR = 0.245, 95% CI: 0.103, 0.580; $p = 0.001$), limiting the amount of food consumed (OR = 0.088, 95% CI: 0.032, 0.236; $p = 0.000$), had to choose between buying food or buying textbooks (OR = 0.094, 95% CI: 0.012, 0.714; $p = 0.022$), consumed FV that had been spoiled after removing the spoiled parts (OR = 7.291, 95% CI: 1.010, 52.603; $p = 0.049$), and watered down infant formula (OR = 511.271, 95% CI: 3.865, 67,637.290; $p = 0.012$) No association was found between FI and carotenoid levels
Soldavini et al. [43]	Assess the prevalence of FI and determine associated factors with the sub-classes of food security	$n = 4829$ students (72.0% female; 69.5% white) from a large public university in North Carolina	Online survey included USDA 10-item AFSSM and sociodemographic questions	22.2% FI in the last year (18.8% low FS; 3.4% very low FS) Factors significantly related to FI included being male, African American, having dependent children, having ≥ 1 part time jobs, recipient of financial aid, sophomore or junior status, lower perceived health rating, and cooking frequency (those that sometimes or often cooked)
Soldavini et al. [44]	Assess the impact of COVID-19 on FI	$n = 2039$ students (73.0% female; “predominately” white) at a large, public university in the Southeast	Online survey included USDA 10-item AFSSM and sociodemographic questions (June 12–July 16, 2020)	Difference in FI levels from before COVID-19 to during COVID-19 was an increase of about 33% (10.8% overall FI, 6.4% low FS, 4.4 very low FS pre- vs. 14.5% overall FI, 7.7% low FS, 6.8% very low FS during COVID-19) 12% of FI status improved, 68% unchanged, and 20% of FI status became worse

Table 1 (continued)

Reference	Study Objective	Population	Assessment	Results
Soldavini et al. [45]	Determine the prevalence of FI and associated factors	<i>n</i> = 4819 students (72.0% female; “predominately” white) at a large, public university in the Southeast	Online survey including USDA 10-item AFSSM and sociodemographic questions	22.2% FI in the last year Grad students experienced less FI compared to undergrads (17.8% vs. 25.81%) Factors significantly related to FI in both grad and undergrad students included age, race/ethnicity, dependent children, enrollment status, employment status, having a car, financial aid, and perceived health rating Factors significantly related to less FI in undergrads were year in school, BMI, having a meal plan, cooking frequency, and residency Factors significantly related to less FI specifically in grad students were perceived cooking skills and marital status
Spaid et al. [46]	Assess FI status among community college students	<i>n</i> = 217 community college students (59.0% female)	Survey including USDA HFSSM (Maroto’s modified version) and measures of student success	52% FI in the last year Significant correlation between food insecurity and energy level Highest rates of FI among single parents and females of color 53% FI among single parents
Umeda et al. [47]	Determine the association between FI, depression, and pain	<i>n</i> = 126 students (54.6% male; 48.3% Hispanic) from a Hispanic-serving institution located in the southwestern USA	Survey including USDA 10-item AFSSM; BDI-II depression scale; abbreviated bodily pain scale; and sociodemographic questions	24% FI in the past month FI had higher reports of pain interference (<i>p</i> = 0.006) but depression scores were not significantly different (<i>p</i> = 0.064)
van Woerden et al. [48]	Determine the relationship between FI and meal plans	<i>n</i> = 1435 1st year students (62.5% female) at Arizona State as part of the SPARC study	Survey including USDA 6-item AFSSM and sociodemographic questions	FI assessed (in the past month) as 36% and 35% at the ends of fall 2015 and spring 2016 semesters FI was higher in individuals on the less expensive meal plan (8 meals/week) compared to those on the more expensive unlimited meal plan (OR = 2.2, 95% CI: 1.2, 4.1)
Wattick et al. [49]	Assess the associations between FI, diet, and depression	<i>n</i> = 1956 college students (67.5% female) at West Virginia University	Online survey including USDA 10-item AFSSM and diet and mental health screeners	36.7% FI in the past month Associations between having depression and FS status (<i>p</i> < 0.0001) FI was a significant predictor of depression

Table 1 (continued)

Reference	Study Objective	Population	Assessment	Results
Weaver et al. [50]	Determine the prevalence of FI and associations with academic performance	<i>n</i> = 2055 undergrads (56.5% female; 68.8% white) at a mid-sized New Jersey public university	Online survey included USDA 10-item AFSSM; GPA data; and sociodemographic questions	48% FI (17.1% low FS; 30.9% very low FS) in the past month Factors significantly related to being FI were sex (women), race/ethnicity (African Americans and Hispanics), having only a partial or no meal plan, commuters, and those receiving financial assistance FI increased the likelihood of having a lower GPA
Willis et al. [51]	Assess the impact of FI on various health and social outcomes	<i>n</i> = 300 undergrads (73.3% female; 77.7% white) at an urban university in the Mid-West	Online survey included USDA 6-item AFSSM; 10-item CES-D scale for depression; and diet, exercise, and sociodemographic questions	30% FI in the past month FI was significantly associated with poor health ($p < 0.001$), overweight/obesity ($p < 0.01$), and mental health ($p < 0.001$) specifically depression
Wooten et al. [52]	Determine the prevalence of FI and associated factors	<i>n</i> = 4824 college students (excluding freshmen; 70.1% female; 81.4% white) at a large public, university in the Southeastern portion of the USA	Online survey included USDA 10-item AFSSM; academic standing; and sociodemographic questions	36% FI (16.1% low FS; 19.5% very low FS) in the last year FI was significantly associate with previously experiencing FI ($p < 0.001$), financial status ($p < 0.001$), and self-reported GPA ≤ 3.85 ($p < 0.001$)

AFSSM Adult Food Security Survey Module, AOR adjusted odds ratio, BDI-II Beck Depression Inventory II, BMI body mass index (kg/m²), CAFPAS Cooking and Food Provisioning Action Scale, FI food insecurity/food insecure, GPA grade point average, FSSM Food Security Survey Module, FV fruits and vegetables, HBCU Historically Black Colleges and Universities, HEI Healthy Eating Index, HFSSM US Household Food Security Survey Module, MSPSS Multidimensional Scale of Perceived Social Support, NCAA National Collegiate Athletic Association, NCI National Cancer Institute, NHANES National Health and Nutrition Examination Survey, OR odds ratio, PHQ-9 Patient Health Questionnaire-9, PR prevalence ratio, PSQI Pittsburgh Sleep Quality Index, SCOFF Sick, Control, One stone, Fat, Food questionnaire, SSB sugar-sweetened beverages YRBS Youth Risk Behavior Surveillance System

Table 2 Food insecurity prevalence levels

	No. of studies	Overall % FI [range]	% low FS [range]	% very low FS [range]
Overall, <i>n</i> = 10,0167	47	32.2 ± 12.9 [9.9–72.9]	17.9 ± 6.0 [7.1–26.6]	15.8 ± 8.0 [3.4–34.5]
Four-year institutions, <i>n</i> = 99,784	45	32.7 ± 12.9 [9.9–72.9]	—	—
Two-year institutions, <i>n</i> = 13,937	2	37.8 ± 20.1 [23.6–52]	—	—
College students, non-athletes, <i>n</i> = 99,269	45	34.2 ± 12.4 [14.0–72.9]	—	—
College students, athletes, <i>n</i> = 898	2	12.3 ± 3.4 [9.9–14.7]	—	—
6-item AFSSM Short Form survey, <i>n</i> = 20,060	17	34.3 ± 12.1 [14.0–60.0]	24.5 ± 2.3 [20.2–26.4]	18.7 ± 8.9 [11.3–34.5]
10-item AFSSM survey, <i>n</i> = 64,794	24	30.3 ± 10.1 [9.9–48.0]	16.2 ± 5.3 [7.1–26.6]	15.1 ± 7.0 [3.4–30.9]
18-item HFSSM survey, <i>n</i> = 663	3*	33.8 ± 18.5 [15.0–52.0]	—	—
2-item survey, <i>n</i> = 14,280	3*	43.7 ± 25.9 [23.6–72.9]	—	—
“Other,” <i>n</i> = 579	1	52.8	—	—

*One study used both the 18-item HFSSM and 2-item surveys

the 2-item (43.7 ± 25.9%; range 23.6–72.9%) and “other” (52.8%) yielded results that were much higher.

Factors Associated with Food Insecurity in College Students

Demographic, Sociocultural, and Socioeconomic Factors

Several factors that were investigated in the 47 studies were correlated with the level of FS reported. Race and ethnicity are factors that are associated with a higher risk of FI. When analyzing the data from the current review for studies with overrepresentation of Hispanics and Black/African Americans, the combined % FI is 35.0 ± 14.8% (range 14.0–72.9%). The highest prevalence of FI (72.9%) was in the study by Duke et al. performed in a population of students from a historically Black college or university [17]. Only El Zein et al. [18] specifically reported on FI prevalence among international students and noted that it was higher (37.6%) than the entire student population (32.0%) at one university, though this was still significantly lower than the rate for Black students (61.7%) [19].

Other demographic factors identified as being associated with increased FI were the female sex/gender, being a single parent, and having dependent children. In an analysis by the Institute for Women’s Policy Research [54], 22% of all undergraduate students are parents. Among students raising children while in college, 70% are mothers, and of these, 62% are single parents. In the US, single mothers with children in the household have the highest rates of FI (27.7%) of any household composition [55]. Considering this data and the fact that a larger proportion of the college student population is female (60%) [2] may provide at least some explanation for the higher rates of FI among college students compared to the general population.

Educationally related factors associated with FI include being a first-generation college student, parental education of high school level or below, and having undergraduate status. First-generation college students are more likely to come from low-income, poor, or working class backgrounds (57%) compared to continuing generation students (12%) [56]. No direct cause is known for why graduate students have lower rates of FI than undergraduate students—are more resources available to graduate students than undergraduates, or are they just more likely to come from more financially stable backgrounds? Socioeconomically, students receiving financial assistance (specifically Pell Grants) had higher rates of FI. Considering access to food, it is not surprising that having a limited meal plan or no meal plan was associated with increased FI. Lack of accessibility to food may also potentially explain why students living off campus and those who do not have access to a car reported increased levels of FI. Finally, food security status may vary for students depending on the time of the semester. The prevalence of FI was higher at the end of the fall and spring semesters compared to the beginning when financial assistance is greater and campus meal plans have not been depleted.

Food Insecurity and Outcomes

The authors of the reviewed literature identified many relationships between FI and specific outcomes among college students. To begin, the outcome most notably unique among this group compared to the general population is academic performance. Higher rates of FI among college students were consistently associated with lower grade point average. There is evidence that dietary behaviors (e.g., eating breakfast) and quality (e.g., increased fruit and vegetable consumption) are related to better academic outcomes [57]. In this review, FI was related to dietary behaviors and quality such as increased frequency of skipping meals; lower fruit, vegetable, and fiber intake; and increased intake of

added sugars, processed foods, fast food, dairy, and calcium. Conversely lower FI was associated with higher rates of nutrition literacy, which has been shown to predict adherence to healthier dietary patterns [58]. In regard to FI and other health outcomes, college students experiencing FI were more likely to report poor overall health than students not experiencing FI. These health metrics included less frequent medical visits/exams, poor mental health, increased psychological stress, increased depression, poor sleep quality, disordered eating/eating disorders, increased obesity, less physical activity, increased tobacco and marijuana use, and higher rates of binge drinking. College students experiencing FI employed various coping strategies to meet their food needs such as more frequent attendance at events that offered free snacks and meals, increased use of food pantries, greater frequency of skipping meals, decreasing portion sizes, stretching the available food over a longer period of time, and purchasing low-cost, highly processed foods. While it remains out of the scope of this paper to offer specific solutions to address FI on college campuses, strategies currently being employed include on-campus food pantries and food recovery from campus events directed to students.

Food Insecurity Among Collegiate Student-Athletes

There are only two published studies in peer-reviewed journals that have assessed the prevalence of FI among collegiate student-athletes [10••, 38••]. The average prevalence of FI for student-athletes (see Table 2) was $12.3 \pm 3.4\%$ (range 9.9–14.7%) much lower than the general college student population and more in line with the national average. However, this value is much lower than the results of the Hope Center survey for student-athletes (23% from 4-year institutions and 39% from 2-year institutions) [5]. One explanation for this difference could be that there was a wider variety of schools from across the country in the Hope Center survey compared to the two studies where the samples were from one Division I program and Division III athletes from schools nationwide. Poll et al. studied the relationship between FI and disordered eating in a population of male NCAA Division I student-athletes (mostly football players) at a single institution in the southeastern USA and found a 9.9% prevalence of FI [38••]. They also queried the participants about their FS in high school, and 13.5% reported being FI at that time. Collegiate FI status was significantly associated with preoccupation with food and keeping food or hiding food but not with binge eating. As observed in the general college student population, preoccupation with food was significantly correlated with having experienced FI before coming to college (i.e., in

high school). No correlations between FI and race/ethnicity were reported in this study.

Brown et al. reported a 14.7% prevalence of FI over the previous 12 months in a nationwide sample of NCAA Division III student-athletes [10••]. The prevalence of FI among subjects who self-identified among the following racial/ethnic groups was 13.3% for white, 18.3% for Hispanic, 31.0% for Black/African American, and 8.5% for Asian. The level of FI was higher for those without a meal plan, those receiving a Pell grant, first-generation college students, and those who have previously experienced FI. Subjects that experienced FI self-reported a negative impact on academic and athletic performance. Contributing factors to FI reported by student-athletes were dining hall hours conflicting with practice times (45.4% of subjects), games during dining hours (22%), and living off-campus with limited money (14.6%).

Since there are so few peer-reviewed, published articles on FI and student-athletes, it is worth discussing a master's thesis [59] and dissertation [60] on the topic that, although not published, have undergone a rigorous review process. In a master's thesis by Anziano [59], 18 NCAA Division II student-athletes were interviewed about their level of FS and 61.6% ($n = 11$) reported having some level of FI which is much higher than in the published work by Poll et al. [38••] and Brown et al. [10••]. It is important to note the small sample size of this qualitative thesis study and consider possible self-selection bias of participants. Contributing factors to FI that were identified by Anziano [59] were limited access to transportation, limited cooking facilities, lack of time to cook or prepare meals, and lack of food options in the dining hall [59]. Outcomes for those experiencing FI were similar to those found in Brown et al. [10••] including self-report of a negative impact on athletic performance. Identified coping strategies were similar to those found in this review mentioned previously.

In a dissertation by Misener [60], 424 Division III student-athletes on 22 teams from a primarily white, liberal arts college in Western Pennsylvania completed a survey to assess the prevalence of FI. Using the 6-item AFSSM Short Form, 129 (29%) were found to experience some level of FI, which was higher than Brown et al. [10••], who also surveyed students at DIII schools. The student-athletes in Misener's research specifically reported cutting the size of their meals or skipping meals because they ran out of money. Twenty-six percent reported eating less than they felt they should have in the last year because they did not have enough money or food. The teams with the highest percentage of FI were women's cross country (80%) and men's field athletes (67%). The reason 23.8% reported not eating a meal is because they ran out of meal swipes. About one-third (29.7%) reported being unable to afford balanced meals.

Impact of COVID-19 on Food Insecurity in College Students

The impact of COVID-19 on FS of college students was only evaluated in three studies [13, 16, 44]. Davitt et al. assessed food security over 30 days during the spring of 2020 and determined that 17.0% of respondents were classified as FI [16]. Soldavani et al. looked at specific changes in FS status and found that 12% had improved status, 68% unchanged, and 20% became worse [44]. In contrast, Christensen et al. reported no differences in prevalence of FI pre-COVID-19 compared to during COVID-19 [13]. In the two longitudinal studies, the sampled populations were predominantly white and female students at single institutions (Soldavani et al. [44] in the southeastern USA and Christensen et al. [13] in the Midwest) prior to the start of the COVID-19 pandemic and the spring of 2020. The timing of the surveys between these two studies may help explain this discrepancy in that Soldavani et al. [44] surveyed students in June and July of 2020, while Christensen et al. [13] surveyed students earlier in April 2020. In addition, different FS assessment tools were used for these studies. Soldavani et al. [44] reported that moving in with family and receiving financial support from family appeared to have a positive impact on students' FS status.

Limitations

The lack of published peer-reviewed studies on collegiate student-athletes prevents conclusions from being made on this population. Student-athlete resources vary widely across athletic division and location leading to variability in the limited data available. In the general college student studies, the validity of the assessment tools available has been questioned. Ames et al. used the 10-item AFSSM in their assessment of 478 students [7]. They concluded that this survey may lead to inaccurate results in college students due to the questions relating to household FS which may not be appropriate for the specific living situations of the college population. This survey tool was used in 24 of the reviewed studies (66% of total subjects). Self-selection bias could also influence the results as students who are FI may be more likely to participate in a study on this topic. Lastly, our convenience sample was primarily white and female and may not be indicative of other demographics.

Conclusion

This review of the literature further confirmed that FI exists among the general college student population. It also confirmed that there is a lack of peer-reviewed, published literature that addresses FI and collegiate student-athletes. The

information gleaned from studies summarized in this article address not only the potential impact of FI on academic performance in the classroom, but also the potential impact outside the classroom. This can include the impact on athletic performance and health and wellness of student-athletes, even if a lack of scientific evidence is not yet available to support it. We found parallels between the peer-reviewed, published, and unpublished studies on both the general college student population and collegiate student-athletes implying that student-athletes are a small subset of college students that have the same challenges, if not more, around FI. The long-term implications of COVID on the prevalence of FI on college campuses are yet to be explored. Future studies will need to assess the effectiveness of initiatives at decreasing the prevalence of FI on college campuses and factors that may contribute to FI among specific segments of the college population such as student-athletes.

Compliance with Ethical Standards

Conflict of Interest Elizabeth L. Abbey declares that she has no conflict of interest. Melissa Brown declares that she has no conflict of interest. Christine Karpinski received a grant from Aramark to support her student-athlete nutrition and food insecurity program. This is one of the types of solutions discussed in this article, but this specific program is not included.

Human and Animal Rights and Informed Consent All reported studies/experiments with human or animal subjects performed by the authors have been previously published and complied with all applicable ethical standards (including the Helsinki declaration and its amendments, institutional/national research committee standards, and international/national/institutional guidelines).

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