

Do the SCOFF items function differently by food-security status in U.S. college students?: Statistically, but not practically, significant differences

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ABSTRACT

Despite food insecurity (FI) being associated with eating disorders (EDs), little research has examined if ED screening measures perform differently in individuals with FI. This study tested whether items on the SCOFF performed differently as a function of FI. As many people with FI hold multiple marginalized identities, this study also tested if the SCOFF performs differently as a function of food-security status in individuals with different gender identities and different perceived weight statuses. Data were from the 2020/2021 Healthy Minds Study ($N = 122,269$). Past-year FI was established using the two-item Hunger Vital Sign. Differential item functioning (DIF) assessed whether SCOFF items performed differently (i.e., had different probabilities of endorsement) in groups of individuals with FI versus those without. Both uniform DIF (constant between-group difference in item-endorsement probability across ED pathology) and non-uniform DIF (variable between-group difference in item-endorsement probability across ED pathology) were examined. Several SCOFF items demonstrated both statistically significant uniform and non-uniform DIF ($ps < .001$), but no instances of DIF reached practical significance (as indicated by effect sizes pseudo $\Delta R^2 \geq 0.035$; all pseudo ΔR^2 's ≤ 0.006). When stratifying by gender identity and weight status, although most items demonstrated statistically significant DIF, only the SCOFF item measuring body-size perception showed practically significant non-uniform DIF for perceived weight status. Findings suggest the SCOFF is an appropriate screening measure for ED pathology among college students with FI and provide preliminary support for using the SCOFF in individuals with FI and certain marginalized identities.

1. Introduction

Food insecurity (FI) refers to a lack of reliable, adequate access to safe foods (McIntyre & Rondeau, 2009). College students may be particularly vulnerable due to limited financial resources and challenges balancing paid versus educational opportunities (e.g., Christensen et al., 2021; Payne-Sturges et al., 2018). A review of FI prevalence among U.S. college students suggested that approximately one out of every two students may be considered food insecure (Nazmi et al., 2019). Adults with FI may be more likely to present with elevated eating-disorder (ED) pathology than those without FI (Hazzard et al., 2020). The FI/ED relationship has also been repeatedly observed in college students (e.g., Barry et al., 2021; Christensen et al., 2021; El Zein et al., 2017; El Zein et al., 2019; Royer et al., 2021), even after accounting for internalizing

symptoms that contribute to ED pathology (Zickgraf et al., 2022). Risk for binge eating generally (Hazzard et al., 2022; Hooper et al., 2022) and for bulimia nervosa (i.e., a pattern of binge eating and compensatory behaviors accompanied by body-image concerns) may be particularly strongly tied to FI (Christensen et al., 2021; Lydecker & Grilo, 2019).

As young adults with a FI history often demonstrate elevated ED pathology (Darling et al., 2017), it is essential to establish whether existing ED screening measures can accurately assess ED symptoms in the context of FI in young adults. Attending to how ED measures perform in individuals with FI is especially important, given that certain behaviors may look similar in disordered eating and FI, despite distinct underlying functions (Christensen et al., 2022). For example, meal skipping or reducing intake may occur both in FI due to low food availability (Richards et al., 2023) and in EDs due body weight/shape

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concerns. Similarly, cognitive dietary restraint may occur in both EDs and FI (Gomez & Perez, 2022). Restraint primarily resulting from FI may occur with the intended primary function of conserving food resources (Middlemass et al., 2021; Laraia, 2013), whereas ED-based definitions of restraint posit that the intended function is weight loss or avoiding weight gain (Herman & Mack, 1975). During ED screening, providers must be able to recognize when a student would benefit from ED referrals, resources to ameliorate FI, or both. Further, ED researchers and clinicians alike must be mindful not to pathologize FI when interpreting measures.

Minimal research has evaluated if ED measures perform differently as a function of FI. In the only existing study on this topic to our knowledge, O'Connor et al. (2022) reported that Eating Disorder Diagnostic Scale (EDDS) items assessing 1) eating large amounts without physical hunger and 2) negative emotions about overeating demonstrated differential item functioning (DIF) as a function of FI. These items were *more* likely to be endorsed given FI and low ED pathology but *less* likely to be endorsed given FI and high ED pathology. In contrast, DIF was not indicated on an abbreviated Eating Disorder Examination-Questionnaire (EDE-Q). Results provide preliminary evidence that the endorsement of certain ED symptoms in the context of FI may not lend itself to intuitive conclusions about level of ED pathology.

A commonly used screening measure for EDs is the SCOFF (Morgan et al., 2000), a five-item measure with good sensitivity and specificity for detecting EDs. The SCOFF items are intended to measure 1) self-induced vomiting, 2) concern about losing control over eating, 3) weight loss, 4) self-perception as 'too fat', and 5) food 'dominating' life. In a German population sample of teens and adults, the SCOFF item assessing food dominating one's life performed differently by socioeconomic status, although modeling group difference in performance on this item did not significantly improve fit (Thielemann et al., 2018). As FI is often associated with lower socioeconomic status (Bove & Olson, 2006; Flores & Amiri, 2019), findings serve as preliminary evidence to support examining the SCOFF for DIF by food-security status. The SCOFF total score is suggested as a cutoff to determine likelihood of having an ED (Mond et al., 2008), so it is essential to understand if the total can be interpreted similarly in the context of FI.

Additional factors or identities could intersect with FI to influence how ED measures perform in certain groups. One such factor may be gender identity. SCOFF items measuring concern about loss-of-control eating and believing one is too fat demonstrated moderate-to-large DIF by gender in a sample of high school students (such that male-identifying students were less likely to endorse both items, ED pathology being equal) (Bean, 2019). Evaluating measure performance in people with marginalized gender identities (e.g., transgender, non-binary, or genderqueer people) is especially important, as people in these groups are at increased risk for EDs (Diemer et al., 2015; Simone et al., 2022), present with greater rates of FI (Arikawa et al., 2021; Linsenmeyer et al., 2021), and are more prone to socioeconomic factors associated with FI (e.g., housing instability, unemployment) (James et al., 2016). ED measure items may perform differently in people with marginalized gender identities due to ED behaviors being potentially driven by desire for gender congruence. Individuals might restrict to outwardly appear more consistent with gender identity or to align with gender-based eating stereotypes (Cusack et al., 2022; Romito et al., 2021), potentially leading to purging behaviors, weight loss, and/or binge eating. Item performance differences may then be compounded by FI; symptoms (such as those measured by the SCOFF) may occur due to desire for gender congruence *and* resource conservation. The combination of gender identity and food FI may translate to differences in the likelihood of endorsing a given item assessing eating pathology. Item performance differences may be related to these factors as opposed to level of eating pathology (as intended by measures of eating pathology).

Individuals with marginalized gender identities experience barriers to community engagement (Mitchell & Soria, 2019) and to engaging with resources intended to alleviate socioeconomic stressors, such as

food pantries (DiGuseppi et al., 2022). One study of transgender and gender non-conforming individuals found that greater gender-identity pride was significantly associated with food-pantry utilization, whereas minority stressors were not (Russomanno & Jabson Tree, 2020). In qualitative research, transgender and gender-nonconforming individuals report barriers to food security and reticence to pursue food assistance (Russomanno et al., 2019). It is crucial to understand how ED measures perform in FI and various gender identities so that ideal resources can be identified when help is sought.

Another factor that may intersect with food-security status to influence ED measure performance is weight status or one's perception of their weight status. For example, the extent to which one thinks about food may be related to being food insecure and perceiving oneself as overweight. Both FI *and* societal pressures to lose weight could increase concern about food and/or loss-of-control eating incrementally beyond the impact of disordered eating. Thus, FI and perceived status as overweight could account for how an item intended to measure eating pathology performs, signaling differences in item endorsement probability that are not related to eating pathology. In contrast, endorsement of food concern or loss-of-control concern may be more accounted for by disordered eating if individuals are food secure and do not perceive themselves as higher weight. Individuals who perceive themselves as having higher weight may experience internalized weight stigma (Mensingher et al., 2018), which could influence one's self-perception of eating behaviors/cognitions as 'disordered' versus socially encouraged. A positive relationship between FI severity and internalized weight stigma has been reported (Becker et al., 2017). The FI/weight status relationship is more complicated, with one meta-analysis indicating that, while FI is associated with risk of higher weight status, severe FI may be associated with being underweight (Moradi et al., 2019). The relationship between FI and one's perception of their weight status may be particularly complicated given that FI is associated with stigma (Pineau et al., 2021), whereas weight loss is often viewed positively in society and even by individuals with FI-induced weight loss (Taylor et al., 2020). ED assessment research with attention to FI *and* one's thoughts about their weight status is needed, as both FI and weight status are associated with experiencing stigma and marginalization (Becker et al., 2021).

1.1. Purpose and hypotheses

Despite the SCOFF being one of the most widely used screeners for EDs, it is unknown if the SCOFF items perform similarly in individuals with FI compared to those without. Items assessing worry about eating or thinking about food may logically perform differently when FI is present. Further, it is unclear if the SCOFF may perform differently as a function of the intersection of FI and other identities (i.e., intersectionality; Crenshaw, 1989). Our study has two aims. First, we report on the DIF of the SCOFF as a function of food-security status. We also report separate DIF results by food-security status in gender identity groups (cisgender or transgender/gender diverse) and in perceived weight status groups (perceive self as overweight or do not perceive self as overweight) to examine these factors' intersection with FI. Based on results from Thielemann et al. (2018) and O'Connor et al. (2022), we hypothesized that DIF of the SCOFF would be indicated as a function of FI. In other words, we hypothesized that SCOFF items may have different probabilities of endorsement in those with food security versus those without at a given equivalent level of eating pathology. We had no a priori hypotheses for which SCOFF items might demonstrate DIF. We also had no a priori hypotheses pertaining to if DIF would be indicated for results reported by gender identity and/or perceived weight status.

2. Method

2.1. Participants and procedure

Participants were undergraduate or graduate students ≥ 18 years of age ($N = 122,269$) from higher education institutions that participated in the Healthy Minds Study annual web survey during the 2020/2021 academic year (Table 1). Institutional Review Board approval of the Healthy Minds Study occurred at participating institutions. Participants provided informed consent as part of the Healthy Minds Study web survey and could skip questions or stop participating anytime. Participants responded to demographic questions and questions about mental health domains/services. Only data from core Healthy Minds Study questions (not optional elective questions) were used. Data are available upon request to the Healthy Minds Study data team.

2.2. Measures

2.2.1. Demographics

Participants indicated their age, race/ethnicity, gender identity, and sexual orientation. The question “What is your gender identity?” provided the following response options, from which more than one could be selected, and an additional option to self-identify a different gender identity: male, female, trans male/trans man, trans female/trans

Table 1
Sample sociodemographic characteristics.

Characteristic	M (SD) or n (%)
Age (in years)	23.68 (7.31)
Elevated eating disorder risk ^a	34,730 (28.4 %)
Food insecure ^b	33,772 (27.6 %)
Perceives self as higher weight	59,534 (48.7 %)
Racial-ethnic identification	
Non-Hispanic White	73,284 (59.9 %)
Non-Hispanic Black	11,211 (9.2 %)
Hispanic/Latin	12,173 (10.0 %)
Asian/Asian-American	14,114 (11.5 %)
Native Hawaiian/Pacific Islander	168 (0.1 %)
American Indian/Alaskan Native	302 (0.2 %)
Middle Eastern/Arab/Arab American	2321 (1.9 %)
Multiracial or a race/ethnicity not listed	8275 (6.8 %)
Missing	421 (0.3 %)
Sex at birth	
Female	87,753 (71.8 %)
Male	34,351 (28.1 %)
Intersex	46 (0.1 %)
Missing	119 (0.1 %)
Gender identity	
Cisgender man	33,356 (27.3 %)
Cisgender woman	83,968 (68.7 %)
Transgender or gender-diverse person ^c	3519 (2.8 %)
Transgender man	548 (0.4 %)
Transgender woman	230 (0.2 %)
Gender queer/non-conforming/non-binary	2355 (1.9 %)
Self-identified a different gender identity	386 (0.3 %)
Missing	1426 (1.2 %)
Sexual orientation	
Heterosexual/straight	92,353 (75.5 %)
Gay/lesbian	4756 (3.9 %)
Bisexual	13,754 (11.2 %)
Questioning	3436 (2.8 %)
Queer only	2316 (1.9 %)
Other	2804 (2.3 %)
Missing	2850 (2.3 %)

Note. Percentages and counts represent observed data.

^a Elevated eating disorder risk operationalized as SCOFF score ≥ 2 .

^b Food insecurity operationalized as responding “sometimes” or “often” to at least one item on the Hunger Vital Sign.

^c Transgender, non-binary, and gender-diverse participants were combined for DIF analyses due to insufficient cell sizes to examine DIF by food security and transgender identity.

woman, genderqueer/gender non-conforming, gender non-binary. To allow appropriately powered comparison groups, gender identity groups for DIF analyses consisted of: cisgender women, cisgender men, and transgender or gender-diverse people.

2.2.2. SCOFF (Morgan et al., 2000)

The SCOFF is a five-item screening measure for EDs evaluating self-induced vomiting, loss of control over eating, weight loss, feeling fat, and perceived centrality of food to life. Items are scored as Yes = 1 or No = 0, with total scores ≥ 2 considered to indicate a probable ED (Mond et al., 2008). A meta-analysis found the measure demonstrated high sensitivity (0.86) and specificity (0.83) across studies (Kutz et al., 2020).

2.2.3. Hunger Vital Sign (Hager et al., 2010)

The Hunger Vital Sign is a two-item measure based on the USDA Food Security Survey Module assessing past-year FI. When referring to the grouping variable intended to assess FI in the current study, we use the phrasing “food-security status” intentionally to be consistent with how this ‘status’ tends to be referred to in a public health context by the U.S. Department of Agriculture (USDA). Specifically, the USDA refers to a range of food security ranging from very low food security to high food security, rather than severe FI to absence of FI, for example.

Respondents were considered food insecure if they answered “often true” or “sometimes true” to at least one of two items: “Within the past 12 months we worried whether our food would run out before we got money to buy more” or “Within the past 12 months the food we bought just didn’t last and we didn’t have money to get more.” The Hunger Vital Sign has demonstrated adequate convergent validity, sensitivity, and specificity (Hager et al., 2010).

2.2.4. Perceived weight status

To assess perception of one’s weight status, participants responded to the prompt “I think I am...” with the response options: very underweight, somewhat underweight, normal weight, somewhat overweight, very overweight. For analyses, responses were dichotomized. “Underweight,” “somewhat underweight,” or “normal weight” responses were coded as “no” to reflect not perceiving oneself as overweight, whereas “somewhat overweight” or “very overweight” responses were coded as “yes” to reflect perceiving oneself as overweight.

2.3. Statistical analyses

Via the *lordif* R package (Choi et al., 2011), DIF analyses examined whether endorsement of each SCOFF item, at a given level of overall ED pathology, differed as a function of (a) food-security status, (b) food-security status and gender identity, and (c) food-security status and perceived weight status. The package employs a combined ordinal logistic regression/item response theory (IRT) method. Levels of the underlying latent construct (‘theta’ in IRT) measured by items serve as the point of comparison for DIF (here, level of ED pathology), rather than observed measure total scores.

Three ordinal logistic regression models examined the current study’s item response predictors of interest. The first included latent level of ED pathology (theta) (Model 1). Second, food-security status (a dichotomous grouping variable) was added (Model 2). Finally, the interaction between ED pathology (theta) and food-security status was added (Model 3).

To determine the potential pattern of DIF, we evaluated both uniform and non-uniform DIF, consistent with DIF analysis recommendations (Zumbo, 1999). Here, uniform DIF would indicate invariable item-level bias within each food-security status group across the full latent spectrum of ED pathology, whereas non-uniform DIF would indicate item-level bias within each food-security status group that varies based on degree of ED pathology. A significant likelihood ratio χ^2 difference test comparing fit between Models 1 and 2 indicated uniform DIF. Likewise, a significant likelihood ratio χ^2 difference test comparing fit

Table 2
Differential item functioning (DIF) model comparisons by food-security status for the SCOFF.

	Uniform DIF		Non-uniform DIF	
	Likelihood ratio χ^2 test p-value	McFadden Pseudo ΔR^2	Likelihood ratio χ^2 test p-value	McFadden Pseudo ΔR^2
Food secure (n = 88,497) vs. food insecure (n = 33,772)				
Item 1 (“Do you ever make yourself sick because you feel uncomfortably full?”)	<.001	0.0002	.11	0.0000
Item 2 (“Do you worry that you have lost control over how much you eat?”)	<.001	0.0002	<.001	0.0001
Item 3 (“Have you recently lost >15 pounds in a 3-month period?”)	<.001	0.0057	<.001	0.0018
Item 4 (“Do you believe yourself to be fat when others say you are too thin?”)	<.001	0.0008	<.001	0.0006
Item 5 (“Would you say that food dominates your life?”)	.93	0.0000	.96	0.0000

Note. Bold indicates statistical significance at $p < .01$ or practical significance at pseudo $\Delta R^2 \geq 0.035$.

between Models 2 and 3 indicated non-uniform DIF. Consistent with best practices, the threshold for what was considered a statistically significant likelihood ratio χ^2 difference test was $\alpha = 0.01$ to ensure a stringent approach that accounts for conducting numerous statistical comparisons (Zumbo, 1999).

We were interested in not only the statistical significance of DIF results, but also the practical significance of DIF results—indicated by effect sizes—considering that statistically significant DIF may reflect differences that are not necessarily practically meaningful (Crane et al., 2007). Effect sizes were presented as changes in pseudo R^2 between each step, which are classified as negligible (pseudo $\Delta R^2 < 0.035$), moderate (pseudo $\Delta R^2 \geq 0.035$ and < 0.070), or large (pseudo $\Delta R^2 \geq 0.070$) (Jodoin & Gierl, 2001). We used McFadden’s pseudo R^2 , which is preferable for logistic regression and is also relatively independent from the base rate of the outcome (Menard, 2000). To conclude that either uniform or non-uniform DIF is present, thresholds for statistical significance ($p < .01$) and practical significance (pseudo $\Delta R^2 \geq 0.035$) should be met for that type of DIF (Gadermann et al., 2018; Jodoin & Gierl, 2001). For examination of DIF by food-security status and gender identity, and by food-security status and perceived weight status, omnibus comparisons in the full sample were conducted first; items demonstrating statistically and practically significant uniform or non-uniform DIF in omnibus comparisons were then examined for uniform or non-uniform DIF, respectively, in post-hoc pairwise comparisons (e.g., comparing cisgender female students with FI to cisgender male students with FI; comparing cisgender female students with versus without FI). Finally, we produced item characteristic curves (which plot the likelihood of item endorsement across latent levels of ED pathology) for items for which both statistically and practically significant DIF occurred.

3. Results

While several items indicated statistically significant DIF by food-security status (Table 2), by food-security status and gender identity (Table 3), and by food-security status and perceived weight status (Table 4), only one instance of practically significant DIF resulted. Results indicated statistically and practically significant non-uniform DIF

Table 3
Differential item functioning (DIF) model comparisons by food-security status and gender identity for the SCOFF.

	Uniform DIF		Non-uniform DIF	
	Likelihood ratio χ^2 test p-value	McFadden Pseudo ΔR^2	Likelihood ratio χ^2 test p-value	McFadden Pseudo ΔR^2
Food secure/cisgender man (n = 25,341) vs. food secure/cisgender woman (n = 60,028) vs. food secure/transgender or gender-diverse person (n = 2167) vs. food insecure/cisgender man (n = 8015) vs. food insecure/cisgender woman (n = 23,940) vs. food insecure/transgender or gender-diverse person (n = 1352)				
Item 1 (“Do you ever make yourself sick because you feel uncomfortably full?”)	<.001	0.0020	.19	0.0001
Item 2 (“Do you worry that you have lost control over how much you eat?”)	<.001	0.0003	<.001	0.0003
Item 3 (“Have you recently lost >15 pounds in a 3-month period?”)	<.001	0.0108	<.001	0.0032
Item 4 (“Do you believe yourself to be fat when others say you are too thin?”)	<.001	0.0032	<.001	0.0014
Item 5 (“Would you say that food dominates your life?”)	<.001	0.0003	<.001	0.0011

Note. Bold indicates statistical significance at $p < .01$ or practical significance at pseudo $\Delta R^2 \geq 0.035$.

Table 4
Differential item functioning (DIF) model comparisons by food-security status and perceived weight status for the SCOFF.

	Uniform DIF		Non-uniform DIF	
	Likelihood ratio χ^2 test p-value	McFadden Pseudo ΔR^2	Likelihood ratio χ^2 test p-value	McFadden Pseudo ΔR^2
Food secure/does not perceive self as higher weight (n = 48,446) vs. food secure/perceives self as higher weight (n = 40,008) vs. food insecure/does not perceive self as higher weight (n = 14,235) vs. food insecure/perceives self as higher weight (n = 19,526)				
Item 1 (“Do you ever make yourself sick because you feel uncomfortably full?”)	<.001	0.0012	.01	0.0001
Item 2 (“Do you worry that you have lost control over how much you eat?”)	<.001	0.0012	<.001	0.0047
Item 3 (“Have you recently lost >15 pounds in a 3-month period?”)	<.001	0.0075	<.001	0.0135
Item 4 (“Do you believe yourself to be fat when others say you are too thin?”)	<.001	0.0043	<.001	0.0369
Item 5 (“Would you say that food dominates your life?”)	<.001	0.0008	<.001	0.0065

Note. Bold indicates statistical significance at $p < .01$ or practical significance at pseudo $\Delta R^2 \geq 0.035$.

for item 4 of the SCOFF (“Do you believe yourself to be fat when others say you are too thin?”) by food-security status and perceived weight status (Table 4; Fig. 1). Post-hoc pairwise comparisons indicated that non-uniform DIF for item 4 was practically significant when comparing

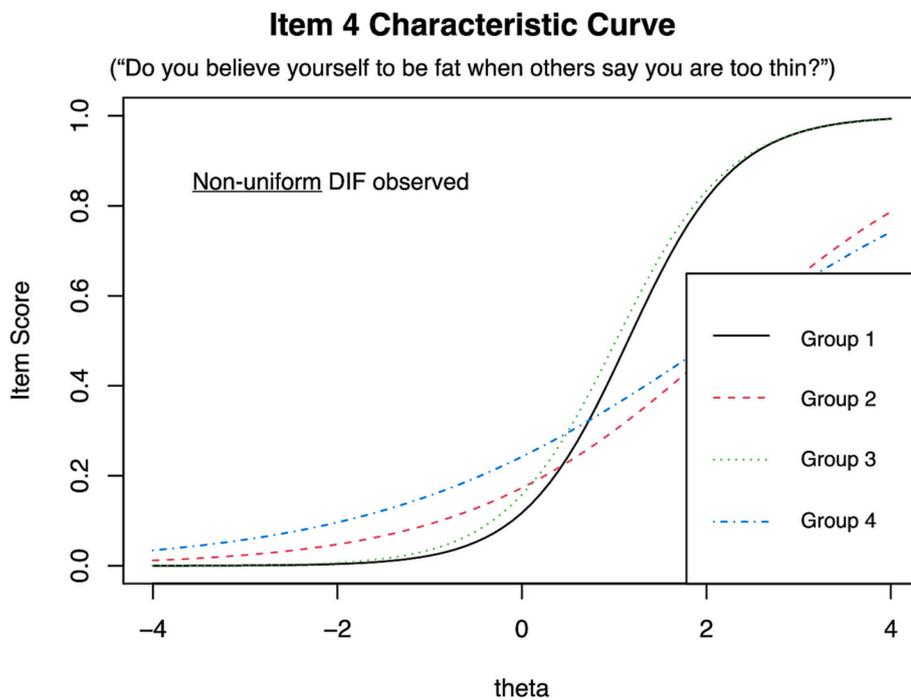


Fig. 1. Item characteristic curve for SCOFF item demonstrating both statistically and practically significant differential item functioning by food-security status and perceived weight status.

Note. Group 1 = food secure/does not perceive self as higher weight; Group 2 = food secure/perceives self as higher weight; Group 3 = food insecure/does not perceive self as higher weight; Group 4 = food insecure/perceives self as higher weight.

food-insecure participants perceiving themselves as higher weight to those with food security who did not perceive themselves as higher weight (McFadden pseudo $\Delta R^2 = 0.0417$), as well as to those with FI that did not perceive themselves as higher weight (McFadden pseudo $\Delta R^2 = 0.0369$). Thus, compared to participants who did not perceive themselves as higher weight (regardless of FI), food-insecure participants who perceived themselves as higher weight were more likely to endorse item 4 at lower levels of ED pathology but less likely to endorse this item at higher levels of ED pathology.

Although pairwise comparisons did not indicate practically significant DIF for item 4 when comparing food-secure participants who perceived themselves as higher weight to any of the other groups defined by food-security status and perceived weight status, the two groups with higher weight perception (i.e., food-secure and food-insecure students perceiving themselves as higher weight) exhibited very similar item characteristic curves (Fig. 1), suggesting that DIF may be driven primarily by perceived weight status. To investigate this possibility, a post-hoc analysis examining DIF only by perceived weight status (irrespective of food-security status) was conducted. Results of this post-hoc analysis indicated that non-uniform DIF for item 4 of the SCOFF exhibited only borderline practical significance (McFadden pseudo $\Delta R^2 = 0.0347$).

4. Discussion

This study tested if items on the SCOFF performed differently (i.e., demonstrated DIF) as a function of FI in a large, college-student sample. Individuals with FI often hold multiple marginalized identities. Therefore, we also tested if DIF of any SCOFF items occurred as a function of (a) food-security status and gender identity, and (b) food-security status and perceived weight status.

Overall, results suggest that the SCOFF is appropriate for screening for eating pathology in college students with and without FI. Consistent with our hypothesis, most SCOFF items had statistically significant DIF (different probabilities of endorsing an item based on food-security status). However, no SCOFF items reached practical significance for DIF, which suggests the measure can be used to screen for eating pathology in college students regardless of FI, as item performance

differences do not represent practically meaningful differences. When considering intersectional identities, SCOFF items did not show practically significant DIF for FI by gender identity. SCOFF items demonstrated non-DIF for the intersectional identity of FI by perceived weight status, except for one SCOFF item. The SCOFF item demonstrating practically significant DIF for FI by perceived weight status was “Do you believe yourself to be fat when others say you are too thin?”. This item was endorsed at a relatively more consistent rate regardless of levels of ED pathology for food-insecure students who perceived themselves as higher weight relative to students who did not perceive themselves as higher weight (regardless of food-security status).

This study provides valuable information validating the use of the SCOFF in college students with FI, suggesting that this screening measure should perform similarly in college students with FI, even when considering gender identity. Results largely converge with previous research by O'Connor et al. (2022), who found no evidence of practically significant DIF in an online crowdsourced sample with versus without FI on the Short EDE-Q and practically significant DIF for two EDDS items. Although items from these ED measures have statistically significant DIF related to FI, most of these differences did not rise to the level of practical significance, suggesting these measures can be used to screen for eating pathology in college students with some caution. Consistent with our findings, researchers and clinicians should consider if an intersection of FI and self-perceived higher weight status is present before using the SCOFF.

Results should be considered in the context of a few limitations. First, although the large sample size gave sufficient power to test for differences between food-insecure and secure groups, this large sample size may have resulted in the overidentification of statistically significant differences (Stark et al., 2004) that did not have practical significance (i.e., meaningful effect sizes). Indeed, in our findings, most SCOFF items demonstrated statistical, but not practical, significance. Another limitation is the sample's restriction to university students. Although FI is relatively common on university campuses, it is unclear if findings would generalize to the broader community of people with FI. Students represent a subgroup of individuals with FI, and as FI is inversely related to income (Walker et al., 2021), people who have the financial means to pursue higher education may differ in certain ways. Third, DIF analyses

necessitated the combination of marginalized gender identities (e.g., transgender, non-binary, genderqueer). As different gender identities may be associated with unique stressors and body-image ideals that drive disordered eating, findings may have differed with ability to look at individual gender-identity groups.

Our study had several strengths. One advantage is the large, geographically and demographically diverse sample, which allowed for examination of important intersections of identities. This study also validated the performance of a common ED screener, the SCOFF, which is of high clinical significance for ED screening in college-health and primary-care settings.

In conclusion, results from our study suggested that the SCOFF may be appropriately used to screen for ED risk in college students both with and without food security. SCOFF items performed similarly in college students when considering intersectionality with gender identity but not entirely so with perceived weight status. Future directions include examining whether SCOFF items demonstrate DIF by FI in other populations, including different developmental groups and adult sub-populations (e.g., veterans, racial-ethnic groups, pregnant persons).

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Contributors

All authors designed the research questions and aims for this secondary data analysis. Dr. Hazzard conducted the statistical analysis. Ms. Richson conducted the relevant background literature search. All authors wrote the first draft of different manuscript sections, and all authors contributed to and approved the final manuscript.

CRedit authorship contribution statement

Brianne N. Richson: Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Supervision. **Vivienne M. Hazzard:** Conceptualization, Methodology, Data curation, Formal analysis, Writing – original draft, Writing – review & editing. **Kara A. Christensen:** Conceptualization, Writing – original draft, Writing – review & editing. **Kelsey E. Hagan:** Conceptualization, Formal analysis, Writing – original draft, Writing – review & editing.

Declaration of competing interest

Ms. Richson, Dr. Hagan, Dr. Christensen, and Dr. Hazzard all declare that they have no conflicts of interest to disclose.

Data availability

The Healthy Minds data are available upon request to the Healthy Minds team.

References

Arikawa, A. Y., Ross, J., Wright, L., Elmore, M., Gonzalez, A. M., & Wallace, T. C. (2021). Results of an online survey about food insecurity and eating disorder behaviors administered to a volunteer sample of self-described LGBTQ+ young adults aged 18 to 35 years. *Journal of the Academy of Nutrition and Dietetics*, 121(7), 1231–1241.

Barry, M. R., Sonnevile, K. R., & Leung, C. W. (2021). Students with food insecurity are more likely to screen positive for an eating disorder at a large, public university in the Midwest. *Journal of the Academy of Nutrition and Dietetics*, 121(6), 1115–1124.

Bean, G. J. (2019). An item response theory analysis of the SCOFF questionnaire in a high school population. *Journal of Evidence-Based Social Work*, 16(4), 404–422.

Becker, C. B., Middlemas, K., Gomez, F., & Kilpela, L. S. (2021). An exploratory examination of internalized weight stigma in a sample living with food insecurity. *Body Image*, 37, 238–245.

Becker, C. B., Middlemass, K., Taylor, B., Johnson, C., & Gomez, F. (2017). Food insecurity and eating disorder pathology. *International Journal of Eating Disorders*, 50(9), 1031–1040.

Bove, C. F., & Olson, C. M. (2006). Obesity in low-income rural women: Qualitative insights about physical activity and eating patterns. *Women & Health*, 44(1), 57–78.

Choi, S. W., Gibbons, L. E., & Crane, P. K. (2011). Iordif: An R package for detecting differential item functioning using iterative hybrid ordinal logistic regression/item response theory and Monte Carlo simulations. *Journal of Statistical Software*, 39, 1–30. <https://doi.org/10.18637/jss.v039.i08>

Christensen, K. A., Forbush, K. T., Richson, B. N., Thomeczek, M. L., Perko, V. L., Bjorlie, K., ... Mildrum Chana, S. (2021). Food insecurity associated with elevated eating disorder symptoms, impairment, and eating disorder diagnoses in an American University student sample before and during the beginning of the COVID-19 pandemic. *International Journal of Eating Disorders*, 54(7), 1213–1223.

Christensen, K. A., Hazzard, V. M., Richson, B. N., & Hagan, K. E. (2022). A call for increased psychometric validation of measures used with populations with food insecurity. *Journal of the Academy of Nutrition and Dietetics*, S2212–S2672.

Crane, P. K., Gibbons, L. E., Ocepek-Welikson, K., Cook, K., Cella, D., Narasimhalu, K., ... Teresi, J. A. (2007). A comparison of three sets of criteria for determining the presence of differential item functioning using ordinal logistic regression. *Quality of Life Research*, 16(1), 69–84.

Crenshaw, K. (1989). Demarginalizing the intersection of race and sex: A black feminist critique of antidiscrimination doctrine, feminist theory and antiracist politics. In , 1989. *University of Chicago Legal Forum* (1:8).

Cusack, C. E., Iampieri, A. O., & Galupo, M. P. (2022). "I'm still not sure if the eating disorder is a result of gender dysphoria": Trans and nonbinary individuals' descriptions of their eating and body concerns in relation to their gender. In *Psychology of sexual orientation and gender diversity*.

Darling, K. E., Fahrenkamp, A. J., Wilson, S. M., D'Auria, A. L., & Sato, A. F. (2017). Physical and mental health outcomes associated with prior food insecurity among young adults. *Journal of Health Psychology*, 22(5), 572–581.

Diemer, E. W., Grant, J. D., Munn-Chernoff, M. A., Patterson, D. A., & Duncan, A. E. (2015). Gender identity, sexual orientation, and eating-related pathology in a national sample of college students. *Journal of Adolescent Health*, 57(2), 144–149.

DiGiuseppi, G., Semborski, S., Rhoades, H., Goldbach, J., & Henwood, B. F. (2022). Perceived safety in community and service settings among young adults experiencing homelessness: Differences by sexual and gender identity. *American Journal of Community Psychology*, 70(3-4), 340–351.

El Zein, A., Shelnut, K., Colby, S. E., Olfert, M., Kattelman, K., Brown, O., ... Mathews, A. (2017). Socio-demographic correlates and predictors of food insecurity among first year college students.

El Zein, A., Shelnut, K. P., Colby, S., Vilaro, M. J., Zhou, W., Greene, G., ... Mathews, A. E. (2019). Prevalence and correlates of food insecurity among US college students: A multi-institutional study. *BMC Public Health*, 19(1), 1–12.

Flores, H. L., & Amiri, A. (2019). CE: Addressing food insecurity in vulnerable populations. *AJN The American Journal of Nursing*, 119(1), 38–45.

Gadermann, A. M., Chen, M. Y., Emerson, S. D., & Zumbo, B. D. (2018). Examining validity evidence of self-report measures using differential item functioning: An illustration of three methods. *Methodol*, 14, 164–175. <https://doi.org/10.1027/1614-2241/a000156>

Gomez, F., & Perez, M. (2022). Motivation for dietary restraint, and disordered eating among adults experiencing food insecurity in the United States. *International Journal of Eating Disorders*, 55(6), 838–844.

Hager, E. R., Quigg, A. M., Black, M. M., Coleman, S. M., Heeren, T., Rose-Jacobs, R., ... Frank, D. A. (2010). Development and validity of a 2-item screen to identify families at risk for food insecurity. *Pediatrics*, 126(1), e26–e32.

Hazzard, V. M., Hooper, L., Larson, N., Loth, K. A., Wall, M. M., & Neumark-Sztainer, D. (2022). Associations between severe food insecurity and disordered eating behaviors from adolescence to young adulthood: Findings from a 10-year longitudinal study. In , 154. *Preventative medicine* (p. 106895).

Hazzard, V. M., Loth, K. A., Hooper, L., & Becker, C. B. (2020). Food insecurity and eating disorders: A review of emerging evidence. *Current Psychiatry Reports*, 22(12), 1–9.

Herman, C. P., & Mack, D. (1975). Restrained and unrestrained eating. *Journal of Personality*, 43(4), 647–660.

Hooper, L., Mason, S. M., Telke, S., Larson, N., & Neumark-Sztainer, D. (2022). Experiencing household food insecurity during adolescence predicts disordered eating and elevated body mass index 8 years later. *Journal of Adolescent Health*, 70(5), 788–795.

James, S., Herman, J., Rankin, S., Keisling, M., Mottet, L., & Anafi, M. A. (2016). *The report of the 2015 US transgender survey*.

Jodoin, M. G., & Gierl, M. J. (2001). Evaluating Type I error and power rates using an effect size measure with the logistic regression procedure for DIF detection. *Applied Measurement in Education*, 14(4), 329–349. https://doi.org/10.1207/S15324818AME1404_2

Kutz, A. M., Marsh, A. G., Gunderson, C. G., Maguen, S., & Masheb, R. M. (2020). Eating disorder screening: A systematic review and meta-analysis of diagnostic test characteristics of the SCOFF. *Journal of General Internal Medicine*, 35(3), 885–893.

Laraia, B. A. (2013). Food insecurity and chronic disease. *Advances in Nutrition*, 4(2), 203–212.

Linsenmeyer, W. R., Katz, I. M., Reed, J. L., Giedinghagen, A. M., Lewis, C. B., & Garwood, S. K. (2021). Disordered eating, food insecurity, and weight status among transgender and gender nonbinary youth and young adults: A cross-sectional study using a nutrition screening protocol. *LGBT health*, 8(5), 359–366.

- Lydecker, J. A., & Grilo, C. M. (2019). Food insecurity and bulimia nervosa in the United States. *International Journal of Eating Disorders*, 52(6), 735–739.
- McIntyre, L., & Rondeau, K. (2009). Food insecurity. In , 188. *Social determinants of health: Canadian perspectives* (p. 204).
- Menard, S. (2000). Coefficients of determination for multiple logistic regression analysis. *The American Statistician*, 54, 17–24. <https://doi.org/10.1080/00031305.2000.10474502>
- Mensingher, J. L., Tylka, T. L., & Calamari, M. E. (2018). Mechanisms underlying weight status and healthcare avoidance in women: A study of weight stigma, body-related shame and guilt, and healthcare stress. *Body Image*, 25, 139–147.
- Middlemass, K. M., Cruz, J., Gamboa, A., Johnson, C., Taylor, B., Gomez, F., & Becker, C. B. (2021). Food insecurity & dietary restraint in a diverse urban population. *Eating Disorders*, 29(6), 616–629.
- Mitchell, T. D., & Soria, K. M. (2019). Community engagement experiences of college students with minoritized sexual and gender identities. *International Journal of Research on Service-Learning and Community Engagement*, 7(1), 11482.
- Mond, J. M., Myers, T. C., Crosby, R. D., Hay, P. J., Rodgers, B., Morgan, J. F., ... Mitchell, J. E. (2008). Screening for eating disorders in primary care: EDE-Q versus SCOFF. *Behaviour Research and Therapy*, 46(5), 612–622.
- Moradi, S., Mirzababaei, A., Dadfarma, A., Rezaei, S., Mohammadi, H., Jannat, B., & Mirzaei, K. (2019). Food insecurity and adult weight abnormality risk: A systematic review and meta-analysis. *European Journal of Nutrition*, 58(1), 45–61.
- Morgan, J. F., Reid, F., & Lacey, J. H. (2000). The SCOFF questionnaire. *The Western Journal of Medicine*, 172(3), 164.
- Nazmi, A., Martinez, S., Byrd, A., Robinson, D., Bianco, S., Maguire, J., & Ritchie, L. (2019). A systematic review of food insecurity among US students in higher education. *Journal of Hunger & Environmental Nutrition*, 14(5), 725–740.
- O'Connor, S. M., Hazzard, V. M., & Zickgraf, H. F. (2022). Exploring differential item functioning on eating disorder measures by food security status. *Eating and Weight Disorders-Studies on Anorexia, Bulimia and Obesity*, 27(4), 1449–1455.
- Payne-Sturges, D. C., Tjaden, A., Caldeira, K. M., Vincent, K. B., & Arria, A. M. (2018). Student hunger on campus: Food insecurity among college students and implications for academic institutions. *American Journal of Health Promotion*, 32(2), 349–354.
- Pineau, C., Williams, P. L., Brady, J., Waddington, M., & Frank, L. (2021). Exploring experiences of food insecurity, stigma, social exclusion, and shame among women in high-income countries: A narrative review. *Canadian Food Studies/La Revue canadienne des études sur l'alimentation*, 8(3).
- Richards, R., Stokes, N., Banna, J., Cluskey, M., Bergen, M., Thomas, V., ... Christensen, R. (2023). A comparison of experiences with factors related to food insecurity between college students who are food secure and food insecure: A qualitative study. *Journal of the Academy of Nutrition and Dietetics*, 123(3), 438–453.
- Romito, M., Salk, R. H., Roberts, S. R., Thoma, B. C., Levine, M. D., & Choukas-Bradley, S. (2021). Exploring transgender adolescents' body image concerns and disordered eating: Semi-structured interviews with nine gender minority youth. *Body Image*, 37, 50–62.
- Royer, M. F., Ojinnaka, C. O., & Bruening, M. (2021). Food insecurity is related to disordered eating behaviors among college students. *Journal of Nutrition Education and Behavior*, 53(11), 951–956.
- Russomanno, J., & Jabson Tree, J. M. (2020). Food insecurity and food pantry use among transgender and gender non-conforming people in the Southeast United States. *BMC Public Health*, 20(1), 1–11.
- Russomanno, J., Patterson, J. G., & Jabson, J. M. (2019). Food insecurity among transgender and gender nonconforming individuals in the Southeast United States: A qualitative study. *Transgender Health*, 4(1), 89–99.
- Simone, M., Hazzard, V. M., Askew, A. J., Tebbe, E. A., Lipson, S. K., & Pisetsky, E. M. (2022). Variability in eating disorder risk and diagnosis in transgender and gender diverse college students. *Annals of Epidemiology*, 70, 53–60.
- Stark, S., Chernyshenko, O. S., & Drasgow, F. (2004). Examining the effects of differential item (functioning and differential) test functioning on selection decisions: When are statistically significant effects practically important? *Journal of Applied Psychology*, 89(3), 497.
- Taylor, E. A., Foster, J. S., & Mobley, A. R. (2020). A qualitative investigation of body weight and weight loss-related attitudes of mothers and fathers in the context of food insecurity. *Eating and Weight Disorders-Studies on Anorexia, Bulimia and Obesity*, 25(6), 1663–1669.
- Thielemann, D., Richter, F., Strauss, B., Braehler, E., Altmann, U., & Berger, U. (2018). Differential item functioning in brief instruments of disordered eating. *European Journal of Psychological Assessment*, 35(6), 823–833.
- Walker, R. J., Garacci, E., Dawson, A. Z., Williams, J. S., Ozieh, M., & Egede, L. E. (2021). Trends in food insecurity in the United States from 2011–2017: Disparities by age, sex, race/ethnicity, and income. *Population Health Management*, 24(4), 496–501.
- Zickgraf, H. F., Hazzard, V. M., & O'Connor, S. M. (2022). Food insecurity is associated with eating disorders independent of depression and anxiety: Findings from the 2020–2021 healthy minds study. *International Journal of Eating Disorders*, 55(3), 354–361.
- Zumbo, B. D. (1999). *A handbook on the theory and methods of differential item functioning (DIF)* (pp. 1–57). Ottawa: National Defense Headquarters.