

REVIEW

College campuses' influence on student weight and related behaviours: A review of observational and intervention research

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Summary

Research indicates that most college students are not meeting dietary and physical activity guidelines, and the average student gains an estimated 1.6–3.0 kg during 4 years of study. College administrations are well-positioned to influence student weight-related health behaviours by ensuring that campus environments/policies promote health. However, to date, campus health interventions have largely addressed individual and interpersonal factors rather than environmental/policy-level changes. Using an ecological perspective, this narrative review synthesizes the literature on campus environmental/policy-level factors (e.g., food availability, physical activity requirements) associated with student diet, physical activity and weight, as well as campus interventions to address these factors. Web of Science and PubMed databases were searched between December 2018 and November 2019. Results indicate that campus food environments may contribute to overconsumption and weight gain, and the number of campuses requiring students to participate in physical activity courses is in decline. Eight examples of environmental/policy-level campus interventions are presented: nutrition labels in dining halls, campus-wide healthy choice marketing campaigns, restricted payment methods for à la cart dining, trayless dining, health-themed residence halls, peer health education programmes, active classroom spaces and physical activity course requirements. Implications for research and health promotion programmes/policies in the field of college health are discussed.

KEYWORDS

college, nutrition, physical activity, weight

1 | INTRODUCTION

The transition from the late teens to the early twenties is an important developmental time period, marked by increasing independence and

autonomy.^{1,2} This transition, dubbed 'emerging adulthood',² represents an opportunity for young people to develop new behavioural patterns, including diet, physical activity (PA) and other weight-related behaviours. Such behaviours may track into later adulthood,^{3–7}

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making this time period a particularly important one for behavioural health interventions. Globally, more than 207 million students (the majority being emerging adults) are enrolled in higher education.⁸ Many students, such as those enrolled in the United States, are enrolled full-time at 4-year institutions that provide housing, dining, recreational facilities, and work opportunities in addition to education.⁹ This type of integrated campus ecosystem may be leveraged to deliver 'high dose' environmental and policy interventions, impacting many students at an impressionable time.

Although college/university campuses provide opportune settings for environmental interventions aimed at undergraduates, research has consistently found that college students are not meeting national dietary and PA guidelines.¹⁰ Weight status among college students is also of concern. In 2018, the American College Health Association (ACHA) reported that roughly 24% of college students had overweight (body mass index [BMI] 25–29.9) and 16% had obesity (BMI 30+), based on adult BMI cut-offs for weight status categories.¹⁰ Meta-analyses indicate that average undergraduate first-year weight gain is between 1.55 and 1.75 kg (or roughly between 3 and 4 pounds).^{11,12} Further analyses show that weight gain during a 4-year college career averages 1.6–3.0 kg (roughly 3.5–6.5 pounds).^{11,13} Findings from this research also establish a significant increase in adiposity among students,¹¹ with reports that some students experience a reduction in fat-free mass in addition to weight gain.^{13,14} Together, these findings suggest that college/university student weight gain is not merely reflective of normal growth and development and that such large cumulative gains may eventually pose serious health threats if left unaddressed.^{11,13}

Previous college health reviews have systematically analysed literature on interventions targeting specific weight-related behaviours (e.g., diet and PA).^{15,16} These reviews, and other primary research studies (e.g., Katterman *et al*¹⁷), have mostly focused on the individual (e.g., knowledge and self-efficacy) or interpersonal (e.g., social support) levels of the social-ecological model. However, to date, there have been no reviews that synthesize evidence around the impact that campus environments and policies have on student weight and related behaviours. To fill this gap, the present review aims to (1) synthesize evidence of the impact that campus environments/policies have on student diet, PA and weight, and (2) identify environmental/policy-level campus interventions that promote healthy eating, PA and healthy weight among students.

2 | METHODS

This narrative review was conducted using the methods outlined by Green *et al*¹⁸ and was compiled using Web of Science and PubMed databases. Searches were conducted between December of 2018 and November of 2019. Search strings included terms related to college (e.g., college and universit*), college spaces (e.g., campus, cafeteria, vending, and residence hall), weight status (e.g., overweight, obes* and body mass index) and weight-related health behaviours (e.g., nutrition, diet*, PA and exercise). Additional searches were

conducted to target campus interventions, including terms such as 'environment*', 'polic*', 'intervention' and 'course requirement*'. The reference lists of retrieved articles were searched for additional articles of relevance. Searches were limited to articles published since 1999.

Searches resulted in identification of 225 articles related to college student weight and weight-related health behaviours. Manuscripts were read and organized by topic in an Excel matrix by CB with input from SS and DH. Data extraction included study design, sample size, sample diversity and outcome variable(s) (i.e., dietary behaviour, PA and weight). Articles fit inclusion criteria if they described campus environments and/or policies related to student diet, PA and/or weight. Articles related to student eating disorders were excluded, as this was outside the scope of this review. Included articles were organized into categories (i.e., observational vs. intervention research) and qualitatively synthesized by energy balance topic (diet and PA).

3 | RESULTS

Sixty studies were identified for inclusion (Table 1). The majority of included studies were quasi-experimental or cross-sectional; sampled predominantly White, female populations and focused on dietary behaviours/nutrition. An equal number of observational ($n = 30$) and interventional ($n = 30$) studies were included. By topic area, 75%

TABLE 1 Descriptive results for articles pertaining to campus environments and/or policies ($n = 60$)

Data	n or median (range)	%
Study design		
Qualitative	7	12
Cross-sectional	19	32
Longitudinal	4	7
Quasi-experimental	26	43
Randomized controlled trial	4	7
Student sample size ^a	368 (14–27,933)	
Sample diversity		
Sample > 50% White ^b	29	88
Sample > 50% female ^c	40	85
Sample included multiple schools	12	20
Sample included 2-year schools	6	10
Outcome(s) of interest ^d		
Dietary behaviours/nutrition	45	75
Physical activity	28	47
Weight	13	22

^aSample size based on articles with student data as unit of analysis ($n = 53$).

^bSample diversity (>50% white) based on articles that report race/ethnicity ($n = 33$).

^cSample diversity (>50% female) based on articles that report sex ($n = 47$).

^dOutcome categories are not mutually exclusive.

($n = 45$) of the included studies measured diet-related variables, 47% ($n = 28$) measured PA-related variables and 22% ($n = 13$) measured weight-related variables.

3.1 | Observational research

Qualitative research has uncovered several environmental and policy-level factors that college students perceive as influencing their diet, PA and weight status.^{19–24} These include unhealthy food availability on campus, food in student dorms, convenience of fast food options, higher cost of healthful foods compared with unhealthy foods, access to an on-campus gym and campus structure/layout. Many of these same factors have been quantitatively linked to student diet, PA and weight outcomes, as discussed below and presented in Tables 2 and 3.

3.1.1 | Nutrition-related environments/policies

Campus dining systems present an opportunity as well as a potential barrier for promoting student nutrition. Cross-sectional studies show that students on an unlimited access (UA) meal plan (as opposed to a point system plan or no plan) have higher fruit, vegetable, dairy and meat (type unspecified) consumption.^{25,26} However, UA meal plans are also associated with consumption of high-fat, energy-dense foods, such as pizza and fried foods.²⁵ UA dining systems may provide an efficient way to feed large student populations and encourage greater consumption of healthful options; however, such systems may also contribute to overconsumption and student weight gain.

In addition to meal plan type, on-campus housing location has been associated with student eating habits, as well as PA and weight. In a large, natural experiment of randomized first-year housing, Kapinos and Yakusheva²⁷ reported that male students who lived in buildings with on-site dining facilities ate more meals and snacks than males who did not live in buildings with dining facilities. Female students who lived in buildings with on-site dining gained more weight and reported fewer exercise bouts per week than females who lived in buildings without on-site dining. In a subsequent analysis, the researchers reported that female students living near a dining hall that was closed on weekends gained 0.45 kg less (1 fewer pound) over the year, on average, than female peers living near dining halls open 7 days per week.²⁸ The campus built environment had no significant effects on male student weight change, even though male eating behaviours were significantly influenced.^{27,28}

In contrast to students housed on campus, students who live off-campus face a different set of nutritional challenges. One reason for this may be that off-campus students are often not on a school meal plan. One cross-sectional study found that students living off-campus exhibited significantly less fruit, vegetable and dairy consumption than on-campus residents.³⁰ Students who lived off-campus were also more likely to have overweight/obesity and to consume more alcohol than those who lived on campus or with parents.³⁰ Additional cross-

sectional research has shown that students living off-campus (including those who lived with family) had less healthy home food availability, ate fewer meals and had poorer dietary intake compared with students living on campus, regardless of socioeconomic status.²⁹ This suggests that exposure to on-campus food environments may offer advantages relative to off-campus environments in terms of healthy dietary behaviours. However, students living on campus have been found to consume more ice cream and grain-based desserts than students living off-campus alone or with peers.²⁹ Collectively, these findings suggest that on-campus meal plan enrolment offers nutritional advantages for students; however, students likely need support navigating campus food options.

Research also speaks to the importance of campus food environments that extend beyond the dining hall and into the dorm room. An observational study of student dorm snacks found that students at a large public university had an average of 47 food/beverage items in their room, totalling 22 888 calories per student.³¹ More than 70% of students had each of the following items: salty snacks, cereal/granola bars, main dishes, desserts/candy and sugar-sweetened beverages. There were no significant differences in the number of food/beverage items by students' meal plan type, sex, class year or roommate status. Notably, the items reported as being purchased by parents were generally higher in calorie and fat content than the items purchased by students.³¹

Energy-dense foods contribute to overeating and weight gain due to their high palatability.⁴¹ Fast food chains and snack companies have made high-calorie foods inexpensive, convenient and widely available to undergraduate populations. For example, many franchises partner with campus administrations to open kiosks at strategic locations on campus and use branding to appeal to student values (e.g., social responsibility and health).⁴² On-campus fast food kiosks can be integrated with dining system payment options (e.g., 'flex points'), offering students easy access through their meal plan. Although fast food is pervasive and easily accessible on and around college campuses, there is some evidence that student fast food consumption might be reduced via manipulation of meal plan components. One cross-sectional study found that students with higher on-campus meal allowances ate less fast food, and students who had 'flex dollar' access to fast food restaurants ate more fast food.³² This suggests dining plans that offer more dining meals and limit use of points for restaurant purchases might reduce student fast food consumption. However, it may also be that students who prefer fast food are more likely to purchase flex dollars. Longitudinal studies are needed to elucidate causality. Future interventions could explore the impact of limiting dining point use to designated 'healthy' items on campuses where restaurant foods are available to students via points.

Finally, financial burden and food insecurity may contribute to weight gain among college students.⁴³ Although research does not show a link between food insecurity and weight in young men, food insecure women have higher average BMIs than women who are food secure.³⁴ According to one article, which pooled survey data from multiple campuses across the United States, more than 50% of both 2- and 4-year undergraduates may be affected by some form of food

TABLE 2 Observational research on nutrition-related environments and policies associated with student weight and related behaviours

Environment or policy	Studies	Student outcomes
Unlimited access dining	Two cross-sectional studies	(+) Students with unlimited access dining consumed more fruits and vegetables ^{25,26} (-) Students with unlimited access dining also consumed more high-fat, energy-dense foods (e.g., pizza and fried foods) ²⁵
Housing with on-site dining	One longitudinal study	(-) Males living in buildings with on-site dining ate more meals and snacks; (-) Females with on-site dining gained more weight ²⁷
Dining service hours	One longitudinal study	(-) Females living near a dining hall open all week gained an average of 0.45 kg(1 pound) more over the year than females living near dining halls that closed on weekends ²⁸
Off-campus housing	Two cross-sectional studies	(+) Off-campus students (living alone or with peers) consumed less ice cream and fewer grain-based desserts than on-campus students; (-) Off-campus students had less healthy home food availability and poorer dietary intakes ²⁹ (-) Off-campus students had less fruit and vegetable consumption, were more likely to have overweight/obesity, and consumed more alcohol ³⁰
Food in dorm rooms	One cross-sectional study	(-) More than 70% of on-campus students had salty snacks, cereal/granola bars, main dishes, desserts/candy and sugar-sweetened beverages in their dorm room; items purchased by parents were generally higher in calories and fat than items purchased by students ³¹
Fast food on campus	One cross-sectional study	(+) Students with higher on-campus meal allowances ate less fast food; (-) Students with 'flex dollar' access to fast food restaurants ate more fast food ³²
Food insecurity	Pooled cross-sectional analysis	(-) More than 50% of both 2- and 4-year undergraduates may be affected by some form of food insecurity, ³³ which has been linked to higher BMI in women ³⁴

Note: Positive (+) and negative (-) outcomes are identified.

Abbreviation: BMI, body mass index.

insecurity.³³ Common food security challenges reported by students included being unable to afford balanced meals, having food not last and being unable to buy more and having to cut the size of meals or skip meals altogether because there was not enough money for food.³³ Food insecurity, which has received relatively little attention on college campuses in the past, is currently becoming a top priority at many institutions.⁴⁴ For example, York College/City University of New York (CUNY) and Community College of Philadelphia have recently opened innovative on-campus food pantries for student use.^{45,46} Research is needed to more fully explore the relationship between student food insecurity and health outcomes (e.g., dietary behaviours and weight), as well as to test the effectiveness of food

security initiatives in promoting social-emotional benefits, academic achievement and other important student outcomes. Feasibility studies should also be conducted to advance understanding of barriers and facilitators to implementation of such programmes.

3.1.2 | PA-related environments/policies

Although factors influencing college student dietary behaviours have received attention, few studies have focused on environmental determinants of undergraduate PA. In the natural experiment conducted by Kaping and Yakusheva,²⁷ researchers found that first-year females

TABLE 3 Observational research on physical activity (PA)-related environments and policies associated with student weight and related behaviours

Environment or policy	Studies	Student outcomes
Housing with on-site dining	One longitudinal study	(-) Females living in a residence hall with on-site dining engaged in intentional exercise less frequently ²⁷
Proximity to fitness centre	One longitudinal study	(+) Females living close to a gym facility reported greater frequency of exercise bouts per week; (-) Females living in a more central campus location reported reduced exercise frequency ^{27,28}
Required PA coursework	Two cross-sectional studies	(+) Females (but not males) have been more likely to report intrinsic motivations for enrolling in PA courses at a university with a PA requirement and to report extrinsic motivations at a university with an elective PA course policy ³⁵ (+) In the presence of PA course requirements, college seniors reported more internalized motivation and less amotivation for PA than first-year students, suggesting a potential shift over time ³⁶
Walkability and/or bikeability of campus	One longitudinal study and 3 cross-sectional studies	(+) An increase in pedestrian network connectivity was associated with longer walked distances and increased likelihood of walking; increased population density was associated with longer walked distances; an increase in bus services was associated with greater walked altitude ³⁷ (+) Cross-sectional studies reported a positive association between students' perceived walkability/bikeability of their campus environment and their physical activity levels ³⁸⁻⁴⁰ and an inverse association with student BMI ³⁹

Note: Positive (+) and negative (-) outcomes are identified.

living in a residence hall with on-site dining engaged in intentional exercise less frequently than students who did not live in buildings with dining facilities. Additionally, living near a gym was positively associated with frequency of exercise bouts per week in female students, whereas living closer to central campus reduced females' exercise frequency.^{27,28} The researchers hypothesized that the reduction in exercise with greater proximity to central campus may have been a result of less time spent walking to academic buildings and student service facilities. No significant associations between housing location and PA behaviour were seen in male students, but this may be due to the small male sample size. Notably, men and women exhibit heterogeneous PA behaviours,^{10,47-49} and similar projects should examine the influence of campus structure on PA outcomes in college men using adequately powered studies. Such findings could inform future campus renovations and/or building use decisions.

Implementation of required PA coursework has been explored as one policy avenue for schools to promote student PA. From a theoretical standpoint, researchers have argued that PA requirements are likely to promote accessibility, cultivate positive PA experiences and

promote life-long PA habits among students.^{50,51} However, recent studies examining associations between PA course requirements and student PA levels are sparse.^{51,52} Although more research directly examining PA outcomes in the context of PA course requirements is still needed, evidence suggests there may be other benefits associated with PA requirements. For example, a cross-sectional study among 612 university students revealed that female students' motivation for enrolling in a PA course was associated with university PA course policies.³⁵ In this study, female students were more likely to report intrinsic motivations (e.g., to have fun) for enrolling in PA courses at a university with a PA requirement and to report extrinsic motivations (e.g., to improve fitness and to exercise regularly) at a university with an elective PA course policy. In contrast, male students frequently reported intrinsic motivation under both conditions.³⁵

More recently, results from a 2018 cross-sectional study found that, in the presence of PA course requirements, college seniors reported more internalized motivation (e.g., exercise is fun and exercise is important) and less amotivation (e.g., exercise is a waste of time and exercise has no point) for PA than did first-year students.³⁶ These

findings suggest that students who were initially amotivated, but compelled to engage in PA by a course requirement, may have learned that they enjoyed PA, felt they were good at PA or came to value outcomes associated with PA. In short, limited research suggests that implementing campus PA requirements might positively impact students' motivation for PA and reach students less likely to engage in PA on their own.⁵¹ However, longitudinal research is needed to confirm this hypothesis and to directly examine PA behaviours as an outcome.

Preliminary research suggests PA requirements have the potential to improve student PA levels. However, evidence from a 2012 study suggests that there have been considerable declines in the number of institutions with physical education requirements from the 1920s/30s through 2010 (97% vs. 40%).⁵³ It is not well understood why institutions are dropping these requirements, although some researchers hypothesize that funding structures may play a role.⁵⁴ Future research should examine the factors influencing institutions to drop physical education requirements, as well as potential incentives to encourage schools to (re-)institute them. Future studies should also specifically examine classes that designate time for performing physical activities, given that prior studies have combined classes designated for performing physical activities and classes that provide non-active, conceptual physical education instruction.⁵³

Few observational studies have explored the impact of walkability and/or bikeability of campus environments, although available evidence suggests such measures are associated with student PA.³⁷⁻⁴⁰ Walkability and bikeability measures take into account aspects of the safety, quality and comfort of the built environment, such as traffic levels, adequate lighting, network connectivity of sidewalks/walking paths, sidewalk surface condition and width, mixed land use and aesthetic design.⁵⁵ Three cross-sectional studies have reported a positive association between students' perceived walkability/bikeability of their campus environment and their PA levels, including self-reported walking,^{38,39} self-reported active transportation,⁴⁰ self-reported total PA⁴⁰ and objectively measured step counts.³⁸ One study also reported that walkability/bikeability was inversely associated with student BMI.³⁹ A longitudinal study of built environment changes at a university in Hong Kong using student walking diaries also revealed positive findings, supporting a potential causal link between the built environment and student activity levels.³⁷ For example, the study reported that an increase in pedestrian network connectivity was associated with longer walked distances and increased likelihood of walking, increased population density resulted in longer walked distances and an increase in bus services resulted in greater walked altitude compared with student activity before these changes occurred.³⁷

3.2 | Intervention research

Interventions that utilize campus environments (e.g., classrooms and residence halls) and related systems (e.g., curricular structures and student-led organizations) have the potential for population-level

impact. Currently, there is limited research describing changes to campus environments and the associated impact on student diet, PA and weight. More often, research studies have tested campus programmes that reach a subset of students and are designed to target individual factors (e.g., knowledge and skills).^{15,16} Table 4 highlights eight approaches that target campus environments (and related systems) in dining, residential and classroom spaces. Such models might form the basis for further development of campus-level interventions to promote healthy eating, PA and healthy weight across diverse student populations.

3.2.1 | Dining-based interventions

Nutrition labelling policies have been well-studied and offer potential for broad impact on college campuses. Studies show that label information is associated with improved student dietary choices and decreased caloric intake.⁵⁶⁻⁶³ Additionally, labels that provide 'contextual' information (e.g., traffic light colours and exercise equivalents) may be more effective than 'textual' calorie information.^{57,59,63} Intervention setting can also influence student use of nutrition labels. Studies conducted in dining halls and quick service restaurants show largely positive results,⁵⁶⁻⁶² whereas studies of vending machine snack choices show few effects.^{78,79} Research examining reasons why student behaviour may be resistant to change in the context of vending labelling is warranted. Feasibility studies for implementing vending labelling interventions in college contexts may also be of use, as previous research indicates large vending suppliers are resistant to change.⁷⁹

In addition to nutrition labelling, general marketing of healthier items may be effective in promoting students' healthy eating. One serial cross-sectional study found that average student fruit intake increased following a 9-day cafeteria-based point-of-selection fruit marketing campaign.⁶⁴ Another intervention study used an array of marketing elements (e.g., point-of-selection indicators, signs, table tents, flyers and benefit-based messages) to promote 10 healthy food items for 3 weeks.⁶⁵ Student self-reported consumption of low-fat salad dressing and cottage cheese increased significantly from baseline, and a trend towards more frequent fruit consumption was also reported. However, no significant changes were reported in student consumption of other promoted items, including steamed vegetables, chicken breast, tossed salad, skim milk, whole grain bread or yogurt, and deli sandwich consumption significantly decreased, leaving some uncertainty about the effectiveness of the intervention as a whole.⁶⁵

A recent study using 'indulgent descriptions' (e.g., twisted citrus-glazed carrots) to label healthy foods in comparison with a 'healthy positive label' (e.g., smart choice vitamin C citrus carrots), a 'healthy restrictive label' (e.g., carrots with sugar-free citrus dressing) or no label (e.g., carrots) found that indulgent descriptions had a significant effect on both the number of diners selecting the vegetable and the amount of vegetable consumed. For example, indulgent labels resulted in 25% more people selecting the vegetable than in the basic condition and 41% more people than in the healthy restrictive

TABLE 4 Examples of campus-level interventions (randomized and quasi-experimental) organized by campus environment (dining, residential and classroom)

Campus space	Intervention examples	Number and types of studies reviewed	Sample size or range	Outcomes
Dining	Nutrition labelling*	13 quasi-experimental studies	120 - >14 000	<ul style="list-style-type: none"> Label information was associated with improved student dietary choices and/or decreased caloric intake⁵⁶⁻⁶³ Labels that provide 'contextual' information (e.g., traffic light colours and exercise equivalents) may be more effective than 'textual' calorie information^{57,59,63}
	Healthy choice marketing*	8 quasi-experimental studies	107 - >27 000	<ul style="list-style-type: none"> Point of selection messaging positively impacted student food selection⁶⁴⁻⁶⁷ A campus-wide social marketing campaign increased student fruit intake and resulted in permanent food system changes on a community college campus⁶⁸
	Restricted payment methods	1 randomized behavioural experiment	191	<ul style="list-style-type: none"> Students randomized to a prepaid card restricted for use on 'healthy items' only (e.g., turkey sandwich, salad and skim milk) consumed more calories from healthier items and fewer calories overall compared with students using cash or unrestricted cards⁶⁹
	Trayless dining	3 quasi-experimental studies	360 - >4000	<ul style="list-style-type: none"> Students dining in a setting without trays took fewer servings and produced less food waste⁷⁰⁻⁷²
Residential	Healthy Active Living (HAL) themed residential halls	1 quasi-experimental study	60	<ul style="list-style-type: none"> Students non-randomly assigned to 'Healthy Active Living'-themed housing engaged in more moderate-to-vigorous physical activity and reported greater fruit and vegetable consumption⁷³
	Peer Health Educators (PHEs)	2 quasi-experimental studies	146-376	<ul style="list-style-type: none"> Students who accessed student leaders (e.g., PHEs) reduced negative health behaviours (e.g., unhealthy dieting)⁷⁴ and reported smaller declines in healthy dietary habits (e.g., fruit and vegetable consumption)⁷⁵
Classroom	Active classroom spaces	1 randomized crossover study	21	<ul style="list-style-type: none"> Standing desk use decreased cardiometabolic risk factors (e.g., fasting blood lipids and glucose and resting blood pressure) and increased metabolic equivalents of tasks (METs) of all student participants⁷⁶
	Physical activity course requirements	1 randomized controlled trial	338	<ul style="list-style-type: none"> A 15-week PA course increased (1) leisure-time PA and (2) strength and flexibility exercises among females only⁵²; 2-year follow-up of the intervention reported no significant effects on PA outcomes between intervention and control groups⁷⁷

Note: Number of studies reviewed, study designs, sample sizes and study outcomes are presented. Asterisk (*) denotes intervention approaches deemed likely to positively impact student health based on the quality, quantity and impact of available evidence. Nonasterisked interventions were identified as having potential for positive impact, but with more limited evidence (e.g., due to small sample sizes, fewer available studies and/or less robust outcomes).

condition.⁶⁶ Further work in the area of taste-focused labelling has revealed sustained positive findings across several campus settings, and researchers now claim that this tactic may be a low-cost strategy to increase healthy food consumption among college students.⁶⁷

Lastly, a campus-wide social marketing campaign *Energize your Life!* used a number of tactics (e.g., brochures, posters, table tents, weekly demonstrations, food service policy changes and increased fruit availability) to increase student fruit intake on a community

college campus.⁶⁸ The intervention lasted for 2 months; however, permanent food service policy changes also resulted from the intervention (i.e., fruit offered in vending machines and fruit cups offered as a substitute for French fries). A cross-sectional pre-posttest analysis of the campaign found that fruit intake significantly increased from baseline,⁶⁸ suggesting that a combination of marketing and environmental/policy-level changes may positively impact student dietary behaviours. Studies using randomized controlled designs and multiple campuses are needed to better characterize the effectiveness of this type of intervention.

Method of payment may also have an impact on student food choice. A study of college lunch payment methods explored the impact of using cash, a prepaid card or a prepaid card restricted to payment for healthier items only (e.g., turkey sandwich, salad and skim milk) on student purchases.⁶⁹ Students randomized to a restricted prepaid card consumed more calories from healthier items and fewer calories overall compared with the other payment methods. Restricted card users also consumed fewer calories from added sugars, total fat and saturated fat.⁶⁹ The controlled study environment, where student payment options were tightly managed, may not fully approximate the experience of free-living students, who often have access to multiple payment options. Further research is needed to understand whether these findings generalize to real-world campus dining settings where students have access to both a restricted card and other forms of payment (e.g., cash). However, this study provides preliminary evidence that use of restricted payment methods for meal purchases might help to promote healthier student meal choices. Such a strategy may be adaptable to à la cart dining venues, such as campus cafés and on-campus fast food restaurants.

Finally, trayless dining has been explored as a mechanism for influencing student food choice. A recent serial cross-sectional article analysing 3153 trays from a 5-day trayless dining intervention found that student food selection was influenced by the removal of trays.⁷⁰ In the trayless dining hall, there was a significant decrease in number of lunch servings, drink servings and dessert servings taken, as well as a decrease in food waste, compared with a control dining hall with trays.⁷⁰ Other studies of college/university dining have also reported decreased food waste when trays are removed.^{71,72} This suggests that removal of dining trays could help attenuate the overconsumption seen in UA dining venues.²⁵ Further research is needed to replicate these findings in diverse settings over longer time periods. Such research would also benefit from collecting longitudinal data on individual-level student consumption and weight outcomes to better understand how trayless dining may affect students' dietary behaviour and health.

In addition to the potential for improved student health outcomes, trayless dining likely has positive implications for food service cost-savings, making it a strong candidate for garnering campus stakeholder support. One study of trayless college dining conducted focus groups with dining hall staff, who reported supporting the trayless initiative as a way to reduce food waste.⁷¹ However, concerns of staff members included increased dishware breakage and need for wiping down tables.⁷¹ It is important that potential unintended consequences

such as these are understood when campuses look to make shifts in dining practices.

3.2.2 | Residence-based interventions

One undergraduate health intervention, published in 2014, highlighted the potential use of college dormitory systems to promote health behaviours.⁷³ Sixty first-year students were assigned to live in either a Healthy Active Living (HAL) residence hall community or a control residence hall, based on preference. Students assigned to a HAL residence community had indicated moderate or strong preference for HAL housing, whereas students assigned to a control community had indicated either moderate preference or ambivalence towards HAL housing. During a 20-week period, the HAL residence hosted nutrition and PA-related seminars, activities and workshops with health professionals. In a pre-posttest analysis, intervention students reported greater moderate-to-vigorous PA as well as greater fruit and vegetable consumption at follow-up (adjusted for baseline) compared with control students.⁷³ This type of in-residence, community-based intervention may be a feasible model for many colleges with typical residential life systems, which utilize trained student staff to facilitate activities. This model may both be cost-effective (as students take the place of salaried staff) and have potential for broad impact.

Similarly, a 3-year study examining the impact of a peer health education programme reported that first-year students who engaged in 'unhealthy weight management behaviours' (e.g., eating according to a special diet and fasting to control weight) were more likely to have contact with peer health educators (PHEs).⁷⁴ However, by their second year, students that connected with PHEs in their first year had decreased their unhealthy weight management behaviours. This suggests that students with unhealthy weight-related behaviours were more likely to seek help from PHEs and that use of PHEs may be an effective strategy for promoting weight-related wellness among students.

A second study that utilized peer student leaders to promote healthy lifestyles on 8 college campuses reported that peer leaders had smaller declines in vegetable consumption over a 12-month period compared with control students.⁷⁵ In other words, all students reported declines in vegetable consumption, but peer leaders involved in the intervention had smaller declines than control students. The researchers hypothesized that the intervention may have attenuated the 'typical' decrease in vegetable consumption seen among students. However, due to the non-randomized recruitment strategy, these trends may also have been a function of systematic differences between active participants and control students (e.g., greater baseline interest in health).

In summary, campus-wide systems that utilize trained students as PHEs or other health/wellness-oriented leaders may be an impactful student health intervention, benefitting both the general student body as well as the leaders themselves. More intervention studies should leverage and evaluate student peer mentors as health promotion

agents to benefit student diet, PA and weight. Additionally, future studies of this kind should make use of rigorous study designs to strengthen potential for causal inference.

3.2.3 | Classroom-based interventions

In addition to promoting campus health in residential environments via student leaders, there is also potential for integrating active themes into classroom spaces. For example, availability of standing desks has been shown to benefit student health. A recent crossover design experiment revealed that, after 3 weeks of standing in class for a minimum of 5 h per week, all student participants ($n = 21$) had decreases in cardiometabolic risk factors (e.g., fasting blood lipids and glucose and resting blood pressure), and their metabolic equivalents of tasks (METs) significantly increased compared with their scores during 3 weeks of sitting.⁷⁶ Because students generally spend long periods of time in class, remodelling the classroom environment with standing desks, and encouraging their use, has the potential for broad impact. More research is needed to confirm these results in larger, diverse student populations over longer time periods. Studies are also needed to explore student receptivity to standing desk use.

Provision of standing desks is likely to be cost-prohibitive for many campuses. Classroom movement breaks might be a cost-effective alternative to standing desks. A mixed methods analysis of student perceptions during a one-semester course with regular activity breaks found that the majority of students appreciated the breaks and felt the breaks improved their focus and engagement.⁸⁰ However, there is currently no evidence to suggest that movement breaks have an impact on weight-related outcomes, and research on this topic is warranted.

Finally, PA course requirements show promise as a way to reach students who are least likely to be active on their own.^{36,51} For example, 'Project GRAD', a university course designed to promote lifelong PA post-graduation, resulted in increased leisure-time PA, including strength and flexibility exercises, among female students immediately following the 15-week course. However, there was no effect on male students' PA levels. A 2-year follow-up of the project reported no significant effects on PA outcomes between the intervention and control groups, suggesting that more research is needed to understand and effectively leverage PA coursework to promote sustained outcomes.⁷⁷

4 | CONCLUSION

Much work is needed to bridge the gap between dietary/PA recommendations and behavioural trends among postsecondary students. Dietary and PA interventions that target campus environments and their related systems show promise for influencing student health outcomes. Based on extensive review of the quality (e.g., study design and sample size), quantity and impact of the intervention approaches reviewed, environmental/policy-level interventions that hold promise

for positively impacting student health were identified (Table 4). Interventions deemed likely to positively impact student health include: (1) nutrition labels in dining halls and (2) healthy choice marketing campaigns. Interventions identified as having potential for positive impact, but with more limited evidence (e.g., due to small sample sizes, fewer available studies and/or less robust outcomes), include: (3) restricted payment methods for à la cart dining, (4) trayless dining, (5) health-themed residence halls, (6) peer mentoring programmes, (7) provision of active classroom spaces and (8) PA course requirements. For all of these intervention approaches, the authors maintain that further research is needed to understand what works best among diverse campus ecosystems.

For the above approaches to be successfully implemented and monitored, partnerships between campus administrations, dining services, wellness groups, recreation departments and others are needed. In order to engage key stakeholders, it will be vital to leverage impact evidence that aligns with outcomes of interest to stakeholder groups. For example, the National Intramural-Recreational Sports Association (NIRSA) used data relevant to campus administrations to rally US institutions to spend billions of dollars on recreational facilities between 2008 and 2013; projects added an average of 89,061 square feet in recreational space and had an average cost of \$20.7 million USD.⁸¹ This was partially achieved via NIRSA-published research that highlighted positive associations between presence and/or use of these facilities and institutional retention rates, individual academic performances and prospective students' decisions about where to attend college.^{82,83} In contrast, institutions may also seek to attract students by offering less healthful amenities. For example, some schools have partnered with restaurant chains to provide easily accessible on-campus fast food kiosks.⁴² These types of partnerships present challenges for those interested in campus health promotion.

Providing supportive nutrition and PA environments/policies across campus domains (e.g., dining, residential and curricular spaces) may prove to be effective and broadly impactful. Efforts in the childhood obesity space have been successful when they enact multiple intervention components simultaneously,⁸⁴⁻⁸⁶ and address both diet and PA in a dynamic, energy balance approach to obesity prevention.⁸⁷ Similar tactics may prove successful in the college space. For example, healthy choice marketing might occur in dining halls but also in residential and curricular spaces. PHEs may be available in residential halls but could also be involved with dining- and classroom-based programmes. HAL residential themes can be developed into an overarching campus culture, infusing dining halls, classrooms and other spaces.

Notably, many of the studies reviewed here involve single-component interventions (e.g., nutrition labels and PHEs), rather than integrated multi-component approaches. Of course, not all campuses provide dining and housing (e.g., commuter campuses). Integrated, multi-pronged efforts may prove to be more challenging in these environments. More research is needed to understand what types of interventions (e.g., multi-media^{88,89}) might work best on campuses with limited student-environment interaction. Previous studies conducted among young adults not enrolled in post-secondary

education may illuminate ways that part-time or commuter campus students can be targeted effectively, as similar health behaviour trends are seen among part-time/commuter students compared with nonstudents.^{90,91} Of course, new research in part-time/commuter student populations is warranted, as this is a growing and understudied population.

Many studies reviewed were conducted among small convenience samples of students from one college or university. Studies that lack arms across multiple campuses, including control campuses, have limited generalizability and may suffer from threats to validity. For example, an intervention may produce successful results on Campus A but not on Campus B due to a variety of factors specific to each campus. Similarly, if positive results are seen at both Campus A and Control Campus C, this would suggest the results were not attributable to the intervention but rather some other factor. Without multiple campus-level comparisons, such confounding factors cannot be identified, and future research should address this gap.

In addition to a need for campus-level comparisons, there is also a need for more diverse research samples at the campus level. The majority of schools described in the research are residential, 4-year institutions, often with predominantly White, female student bodies. Few studies were conducted at community colleges and/or 2-year institutions and few reported samples with greater than 50% historically underrepresented minority student populations.⁹²⁻⁹⁴ For example, there is limited representation of minority serving institutions (MSIs; e.g., Historically Black Colleges/Universities). Thus, little is known about what interventions work best on non-residential, 2-year or MSI campuses, which disproportionately reach public health priority populations. Future research should prioritize engaging MSI campuses in weight-related health intervention studies.

Finally, whereas a number of observational studies did incorporate longitudinal designs, the majority did not. Cross-sectional evaluations provide preliminary evidence that is useful for hypothesis

generation, but they only provide evidence of association and do not allow researchers to examine trends related to the influence of campus practices on student health. However, longitudinal studies of college populations can be especially challenging. Loss to follow-up is often a major issue as students can transfer, graduate or choose to discontinue participation due to busy schedules and competing demands. Training researchers with expertise in navigating these challenges should be a priority for the field.

Much of the current campus intervention literature focuses on diet-related interventions (e.g., nutrition labelling), yet still relatively few unique nutrition strategies have been tested on college campuses. For example, tailored interventions that target student dietary behaviours based on housing status or meal plan type could be explored. Additionally, studies could examine the impact of restricting meal plan points to non-fast food purchases or healthier options at fast food locations. Promising approaches from other domains (e.g., primary/secondary schools⁹⁵ and worksites⁹⁶) may also be worth testing in the college setting.

From an energy expenditure perspective, more studies are needed that explore PA-related policies/programmes, including those that target both classroom and residential spaces. For example, mandatory PA coursework may be a promising strategy for increasing PA levels among students most vulnerable to inactivity. However, mandating PA coursework requires that institutions provide adequate facilities, instructors and courses to meet student capacity, in addition to diverse interests and abilities. For the many schools that are not currently providing these services to all students (or at all), justification of the benefits is needed. In order to target institutions with varying priorities, it will be important for studies to highlight a range of potential benefits, from physical health benefits to academic benefits (e.g., improved grade point average⁹⁷). Activity-promoting residence halls, classroom spaces and general campus structure should complement activity-related coursework, ensuring that students maintain adequate activity across campus domains.

TABLE 5 Recommendations for future research in the field of undergraduate obesity prevention

Priority	Current gap
1. Sample diversity	<ul style="list-style-type: none"> • Two-year schools, community colleges, commuter campuses and minority serving institutions are underrepresented in the literature. • The available research over-represents White and female student populations.
2. Study design	<p>Observational research</p> <ul style="list-style-type: none"> • More longitudinal studies are needed. <p>Intervention research</p> <ul style="list-style-type: none"> • More randomized controlled trials that sample across multiple campuses are needed. • Multi-pronged (factorial design) studies are needed to understand how individual interventions can be successfully combined, as well as to understand the interactions between them. • Promising approaches from observational studies need to be tested using intervention designs (e.g., restricting meal plan points to non-fast food purchases, providing access to on-campus food pantries and improving campus walkability/bikeability).
3. Implementation research	<ul style="list-style-type: none"> • Research is needed to understand factors associated with ease of implementation and sustainability for campus administrations and staff (e.g., exploration of perceived administrative barriers, cost-benefit analyses, documentation of coalition-building best practices and stakeholder engagement strategies).

Other important areas for further research include the efficacy of campus food security initiatives (e.g., student food pantries) in promoting healthy weight. Food insecurity is a pressing issue across the United States on college campuses, and little is known about its effects on student weight and weight-related behaviours, as well as other important outcomes (e.g., academic performance and social-emotional wellbeing).

Finally, research is needed to understand factors associated with ease of implementation and sustainability for campus administrations and staff looking to build healthy campus programmes/policies. Only one study included in this review directly explored factors related to implementation feasibility.⁷¹ Such research might include qualitative exploration of perceived administrative barriers, cost-benefit analyses and documentation of coalition-building best practices. These studies will aid in identifying campus-wide interventions that not only have a positive impact on student health but are also feasible for campuses to implement and sustain (Table 5).

This article is an important contribution as the first narrative review examining environmental and policy-level influences on undergraduate health. However, there are limitations to note. First, the broad scope of literature reviewed here precluded in-depth coding by multiple researchers. Data from campus health articles were primarily reviewed by the corresponding author, with input from co-authors. Second, although this review aimed to characterize the literature targeting promotion of healthy student weight and weight-related behaviours (diet and PA), few articles measured weight/weight status as an outcome variable. Instead, much of the college health literature is focused on dietary behaviours and/or PA as a primary outcome, demonstrating significant focus on the more proximal outcomes related to energy balance. This review is novel in its approach to incorporate studies with both weight-related outcomes and diet and PA behavioural outcomes, which are protective independent of weight; however, additional research with weight-related outcomes is needed.

This is the first narrative review to synthesize knowledge of environmental and policy-level interventions aimed at undergraduate energy balance and obesity prevention on college campuses. Environmental/policy-level campus interventions have the potential to impact large numbers of students during a critical developmental period. This review synthesizes the available studies in order to provide researchers, public health practitioners and campus policy makers with an understanding of the opportunities and knowledge gaps in this field. Recommendations for future research include rigorous, longitudinal testing of interventions (both individually and in combination), including their effects on the health of diverse student populations and their feasibility/sustainability for campus administrations. It is the authors' hope that this article will serve to bring attention to the importance of environmental/policy-level obesity prevention work being conducted at postsecondary institutions and encourage expansion of the evidence base in this area.

CONFLICTS OF INTEREST STATEMENT

The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS

CB, SS, CE, EH, CS and DH developed the research question as part of a larger research initiative. CB, SS and DH conducted the review and analysed the results. CB wrote the manuscript. All authors were involved in the writing process and had final approval of the submitted and published versions.

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