Combining Marketing and Behavioral Research to Develop and Evaluate a Healthy Vending Intervention on a College Campus

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DEDICATION

To my husband
Jared Sowers

And my parents
Ryan and Joell Faulk

For their continued love and support throughout my academic journey.

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ABSTRACT

Objective: To utilize a comprehensive approach for developing and evaluating a healthy vending intervention introducing a healthy bean snack product in campus vending machines to positively impact factors related to college students' dietary behavior. ***Methods:*** The full project included five sequential phases to inform, develop, and implement a vending intervention that introduced a specific healthful dried bean snack product in campus vending machines. First, we conducted multiple-methods cognitive interviews with 60 college student vending users to select the most liked, preferred, and influential product, price, and promotion for the intervention. Next, we used observations and intercept surveys to describe and compare vending contents, sales, and consumer characteristics. We then used intercept interviews to compare awareness, attitudes, and purchases of the intervention product with and without a point-of-purchase promotion. Finally, we implemented the determined intervention and compared changes in perceived healthfulness of campus vending machines and environmental, personal, and behavioral factors related to the intervention product from pre- to post-intervention and between vending and non-vending users. Demographics and vending usage measures were assessed and compared throughout the project. ***Results:*** The five phases included a total of 255 student participants, with a majority being female (63%) and white (82%). Approximately 50% of participants used vending machines at least once per month with the most common reasons for purchasing vending items being hunger, lack of time, and convenience and reasons for choice being price, health, and taste. We also found a significant relationship between higher frequencies of vending usage and higher weight status. The intervention strategy only included the product, due to no significant differences in intervention product awareness, attitudes, or purchase with the promotion. Intervention impact overall was low with only 5 participants (11%) aware of the intervention product. Vending users significantly increased their perceived healthfulness of vending from pre- to post-intervention, with a significantly greater increase compared to non-vending users, after controlling for diet. ***Conclusion:*** This project provides an example of how combining marketing and behavioral research and principles can inform the comprehensive development and measurement of healthy vending interventions on college campuses.

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INTRODUCTION

Weight Gain in College Students

The current prevalence of overweight and obese college students in the United States is estimated to be from 30 to 50 percent, depending on the university, with the national average being 35.1 percent.[1-4] Though this is half of the current prevalence of overweight and obese adults in the U.S.,[5] the prevalence of obesity in the college-aged group, age 18 to 25, has seen the greatest increase of all age groups, more than doubling in the past 30 years.[6] Being overweight or obese as a college-aged young adult can lead to an increased risk of developing serious health conditions such as type 2 diabetes, heart disease, stroke, and certain types of cancer,[7] all of which are within the top 10 preventable causes of death in the United States.[8] A study by Kruger, Roeder, and Brubaker found 73 percent of college students considered to be overweight or obese had at least one risk factor for cardiovascular disease, with 15 percent having multiple risk factors.[1] Therefore, it is imperative to help college-aged students achieve a normal weight to promote the overall positive health of this population.

One strategy to prevent obesity and obesity-related complications is to identify and intervene at the critical period in which there is rapid weight gain.[9] A study by Racette et al. found 70 percent of students surveyed gained a significant amount of weight by the end of their sophomore year, with the average weight gain being approximately 9 pounds.[10] Multiple studies report similar significant amounts of weight gain among college students ranging from 1.96 to 9.9 pounds in the first year of college.[11-18] Particularly, college freshmen gained weight at a much higher rate than the general population of individuals in the same age group not in college.[6, 18] One study reported the average weight gain in adults over the age of 18 years being only 0.02 pounds per week compared to an average 0.35 pound per week gain during the first year of college.[17] The largest amount of weight gain among college students has been shown to occur during the first three months of entering college,[9, 17, 18] with the proportion of overweight or obese students in one study doubling during this time period.[9] Furthermore, weight gained during this time was usually maintained or increased throughout the college years, and often maintained into adulthood.[18]

The high prevalence of overweight and obese college students, and specifically the large amount of rapid weight gain experienced in the first year of college in this population, is an important public health issue.[9] The public health importance of focusing on the college population is also supported by the fact that approximately 19.8 million individuals were enrolled in college in 2016, which encompassed approximately 70 percent of the population of 18 to 25 year-olds at that time.[19] Not only has the proportion of this age group enrolled in college increased by 12 percent since 2006, but it is expected to increase by an additional 3 percent by 2027.[19] Therefore, interventions in the college population provide a unique opportunity to impact a large amount of individuals at a critical time period to reduce the increasing prevalence of overweight or obesity in this age group.[20]

The Transition Period of 'Emerging Adulthood'

The unique characteristics of weight gain in the college population may be related to the distinctive characteristics and experiences of this age group.[6] College-aged students belong to a specific age group of 18 to 25 year-olds often defined as 'emerging adulthood.'[21] This period is marked by the transition from adolescence to adulthood, with individuals more in between rather than distinctly part of either age group.[6, 21] Though individuals in this group experience many changes that increase their responsibilities as an adult, they still possess the dependence and exploration tendencies of adolescence.[21] Ultimately, individuals in this age group are striving to

explore and develop their self-identity, including the development of lifestyles and behaviors that reflect that identify.[6, 21]

Individuals in the 'emerging adulthood' age group often experience many significant life changes, including a newfound autonomy with lifestyle choices and an inclination for exploration.[20, 21] In addition, individuals in this age group are also often experiencing important changes in their surrounding environments and social supports, especially if they are attending college.[6] These changes can impart large influences on individuals in this vulnerable period of life by affecting their decision-making or ability to adapt to new lifestyles or behaviors.[6] The idea of social aspects playing a large role in behavioral decision-making particularly applies to the emerging adulthood age group, where changes in social support and interpersonal influences are instrumental in their development of self-identity.[6] A study by Weiss, Larsen, and Baker found while valuing health and having a desire make changes were the most powerful predictors of college students practicing health protective behaviors, peer influence also largely persuaded their behavioral intention by indirectly affecting their attitudes and beliefs regarding those health behaviors.[22] The inexperienced decision-making and open-mindedness typical of this age-group have also been shown to lead to a higher propensity of risk-taking behaviors, especially in regard to health and social behaviors, compared to older adults.[23] Ideas and habits developed during this critical time could then have a lasting impression on their behaviors throughout their adult life.[24]

College-aged students desiring exploration while they develop critical lifestyle habits make this an ideal time for interventions focused on promoting positive behaviors.[20, 21] However, there is little research available on the behaviors or demographics specific to this age group, due in part to this group being incorrectly grouped with either the adolescent or adult age group, despite the distinct differences.[21] Since the distinctive mindset and experiences of this age group can lead to unique issues, more information is needed on specific strategies that address the distinguishing characteristics of this group.[6, 21]

Dietary Habits of College Students

One common behavior change among college students related to their newfound independence is the change in dietary habits.[11, 25-27] A large number of students, approximately 73 percent in one study,[27] indicate they have experienced changes in their dietary behaviors since starting college, with many identifying the change as a potential reason for their weight gain during this time.[11, 25, 26] Specifically, college students have reported increased negative dietary habits since starting college, including eating less fruits and vegetables and more fast-food, which they believe could have influenced their weight gain.[26, 28] Levitsky, Halmaier, and Mrdjenovic found changes in eating habits were, in fact, significant predictors of weight gain among college students.[17] Some students have identified the transition of eating habits from high school to college as one of the most difficult challenges to adapting to college life.[29] Therefore, college students might need guidance in exploring and developing positive eating habits to prevent weight gain during this critical time of transition.[20, 21]

According to the 2015-2020 Dietary Guidelines for Americans (DGA) and the Healthy People 2020 Nutrition and Weight Status objectives, eating a healthy diet can reduce the risk for obesity, which then reduces many of the associated risks for secondary health conditions.[8, 30] Research by Hu et al. supports this idea with longitudinal evidence indicating college-aged individuals who had higher dietary quality gained 3.3 pounds less weight over 10 years compared to those with lower dietary quality.[31] However, college-aged students' dietary habits often do not align with the dietary recommendations for their age group.[32] Studies indicate, on average, this population consumes excess amounts of calories, fat, saturated fat, and sodium, and deficient amounts of vitamins and minerals, including vitamin A, vitamin D, folic acid, calcium,

magnesium, and zinc.[33, 34] According to McDowell and Devaney, this age group is most likely of all of the age groups to exceed the dietary fat recommendations.[35] The lack of vitamins and minerals intake could be related to low fruit and vegetable intake among college-aged students.[10, 36] The American College Health Association reported in 2018 only 4.8 percent of college-aged students ate the recommended 5 or more servings of fruits and vegetables a day compared to 18 percent of adults aged 18 years or older meeting these recommendations.[4, 37] Larson, Neumark-Sztainer, Hannah, and Story also report college-aged individuals' total fruit and vegetable intake decreased significantly, by more than half of a serving per day, during the five year period after high school.[38] Pliner and Saunders found lower consumption of fruits and vegetables was the only dietary factor which significantly predicted weight gain among college students.[39] Since weight and health are often influenced by caloric balance and nutrient intake, it is important to provide college students with support to help them control their weight by improving their dietary intake.[8]

Another example of poor dietary habits of college students includes the types and amount of eating occurrences common with this age group. Nelson, Kocos, Lytle, and Perry found college students mentioned frequent snacking throughout the day as an important influence on their dietary intake and weight status.[25] Studies found approximately 63 to 79 percent of college students consumed at least one snack daily, with 33.9 and 32.5 percent always or often consuming daytime or late-night snacks, respectively.[40, 41] A longitudinal study by Demory-Luce et al. also found individuals in the 'emerging adulthood' age group consumed significantly more salty snacks than they did when they were 10 years old.[42] Snack size, amount of energy per snack, and total energy from snacking has also significantly increased from 1977 to 2006.[43] An analysis of common snacking patterns of college students found snacks contributed 20 percent of total recommended energy intakes but only 8 to 13 percent of recommended nutrients, on average.[44] In addition, high-fat snack foods made up a larger portion of total calories consumed by the 'emerging adulthood' age group when compared to other age groups.[35] McArthur, Holbert, and Forsythe also found the snack quality index (SQI) scores, reflecting nutrient density of snacks, was lower for snacks college students purchased and consumed on-campus compared to off-campus (21.2 ± 9.3 vs. 23.6 ± 5.5, respectively).[45] The number of snacks eaten per day and the number of times snacks are purchased away from home per week have both shown significant associations with unhealthy dietary behaviors that contribute to weight gain, including significantly higher energy intake, lower fruit and vegetable intake, higher sugar-sweetened beverage intake, and more frequent fast food intake.[46, 47] A study by Levitsky, Halmaier, and Mrdjenovic also found 47 percent of the variance in weight gain among college-aged students was attributed to consumption of junk food and frequency or amount of snack eating occasions.[17] The unhealthy, but frequent, snacking patterns of the 'emerging adulthood' age group, and the potential effect of this pattern on weight gain, provide a potential area for intervention to improve dietary habits in this population.

The unique transition period of 'emerging adulthood' seems to be related to negative changes in dietary behavior, which college students believe could be contributing to their weight gain.[11, 25-27] Specifically, individuals in the 18 to 25 year age-group have higher fat intakes, lower fruit and vegetable intakes, and more unhealthy snacking patterns than other similar age groups, including adolescence, from 12 to 19 years, and adulthood, 18 years and older.[17, 32, 35, 38, 42] All of the previously mentioned dietary behaviors common to college-aged students have also been related to weight gain during this time period.[11, 17, 25, 31, 39] Therefore, interventions focused on improving the weight status of college-aged individuals might benefit from focusing on and correcting these associated negative dietary behaviors common in this population. [8, 30]

Theoretical Models and College Students' Dietary Behaviors

In order to appropriately promote behavior change, it is important to first determine all of the factors that may interact to influence behavior. To explore these factors, we utilized two theories that aim to explain or predict behavior – the Social Cognitive Theory (SCT)[48] and the Theory of Planned Behavior (TPB).[49, 50] The SCT and TPB describe related factors that interact in a way that ultimately influences an individuals' level of self-efficacy, or confidence in their ability to perform a behavior, which then predicts their actual behavior (Figure A.1).[51, 52] These specific important factors, discussed in more detail below, include the actual and perceived barriers or facilitators to a behavior present in an environment, personal knowledge and attitudes, and behavioral abilities and intentions. While both theories focus on environmental, personal, and behavioral factors, they complement one another in that the SCT factors are more external and action-oriented,[48] while the TPB factors are more internal and cognitively-based.[49, 50] Including both theories, and the relationship between them, allows a more holistic view of influences and motivators to actual behavior.

An individual's self-efficacy is believed to be one of the most influential determinants associated with behavioral intention and actual behavior.[51, 52] A study by Anderson, Winett, and Wojcik demonstrates the influence of self-efficacy on dietary behavior with results indicating individuals with higher levels of confidence in their ability to make healthy dietary choices had significantly lower fat, higher fiber, and higher fruits and vegetable intake than those with lower levels of self-efficacy.[53] The SCT and TPB provide examples of influences that ultimately effect behavior through their impact on self-efficacy. For example, the SCT concept of behavioral capability related to self-efficacy is described as the level in which individuals believe they possess the necessary personal knowledge and behavioral skills to perform a certain behavior.[48] The SCT then also implies there is a sense of reciprocal determinism that influences behavior, where personal factors such as an individual's knowledge, ideas, and opinions and behavioral factors including abilities, skills, and competencies both influence and are influenced by how individuals respond to or interact with their environment.[48, 54-57] Furthermore, the TPB suggests the important influence of an individuals' perceptions of their environment, which also influences and are influenced by personal and behavioral factors. According to this theory, perceptions of environmental barriers to a behavior can decrease an individual's perceived behavioral control (PBC), or an individual's perception of the level of difficulty associated with carrying out a behavior.[51, 58-60] This perceived difficulty, or level of control, of a behavior then influences an individuals' self-efficacy with performing that behavior.[48, 59] An individuals' PBC is important because, when also taking into consideration personal attitudes, subjective / social norms, and behavioral intention, PBC has been shown to strongly predict actual behavior.[48, 59]

These theories can be applied to the previously discussed issue of unhealthy snacking behaviors among college students to determine why these behaviors may occur and develop a plan to facilitate positive change in them (Figure A.2). For example, an individuals' personal factors related to opinions and willingness to select healthy snack options combined with their behavioral factors related to their ability and confidence in selecting healthy snack options interact to play a role in their likelihood of actually selecting a healthy snack option. Furthermore, theory suggests the college campus environment interacts with these factors to also play a large role in determining actual snacking behavior.[48, 54-57] Particularly, the degree of positive or negative perceptions of environmental barriers described by the theory of PBC has been strongly associated with actual practice of health and dietary behaviors among college students.[53, 61]

The first potential focus of change is the environment, with evidence indicating the college campus environment provides a particularly important influence on dietary choice and habits of college students.[62] Purchasing foods on campus has been identified as one of the factors most

strongly associated with poor dietary habits among college students.[63] Students in one study who ate on campus more often had a higher intake of fat and added sugar compared to individuals who brought food from home.[62] Some studies also found students who lived on campus, and ate most of their meals on campus, gained significantly more weight than individuals who lived and ate off campus.[11, 64] These results have led some researchers to believe the unhealthy nature of surrounding food environments may be just as much, if not more, of a contributing factor to the rising rates of obesity and related diseases than individual factors such as knowledge, abilities, or motivations.[65, 66] The impact of the environment is further stressed by individuals often not having the insight to understand how the environment is influencing their dietary choices, making them unable to change their unhealthy dietary habits to control for it.[67] Therefore, the surrounding campus environment is an important aspect college students may need help appropriately adapting to in order to develop appropriate lifestyle choices and behaviors.[24, 61]

While the actual environment does impart some influence, the TPB indicates perceptions of the environment may also be important influences of self-efficacy and behavior.[49, 50] For example, the increased perception of environmental barriers to a dietary behavior has been found to strongly predict an inverse relationship with individuals' likelihood of initiating that behavior.[68, 69] One of the main barriers to healthy eating present in the college campus environment identified by college students is the lack of perceived access to healthy foods on campus.[26, 70-72] Many students indicated the higher cost of healthy items compared to less healthy items also acted as a barrier to them choosing the healthier option.[26, 71-74] Another commonly identified barrier was the lack of time to prepare and eat healthy foods, possibly explaining the higher consumption of snack or convenience items.[70-75] Students also identified highly available convenience foods usually being considered unhealthy as an additional barrier to eating healthy.[71, 73] Finally, many students feel they do not have adequate information or knowledge about what is considered healthy, which acts as a barrier by lowering their self-efficacy with choosing a healthy option.[73-75] Conversely, individuals with higher levels of perceived facilitators to healthy eating in their environment often have higher levels of dietary quality and variety.[76] One common facilitator identified by college students was the presence of social support from friends and family who made healthy choices and encouraged them to as well, which aligns with the subjective / social norms concept of the TPB.[71, 77] Another factor that promoted healthy dietary choices among college students was the availability and affordability of healthy foods in their environment.[77] Having nutrition information available for students could also increase their self-efficacy with making positive dietary choices.[73-75] The influences of barriers and facilitators to dietary behavior relate to the principles of the SCT and TPB, in that behavior in individuals will not change if the surrounding environment does not provide the necessary support for those behaviors.[78]

Though the SCT and TPB provide targets for intervention based on those factors that influence behavior, the level in which an intervention is implemented needs to be determined. That being said, many individuals and organizations – including the World Health Organization (WHO), Institute of Medicine (IOM), Center for Disease Control and Prevention (CDC), Healthy People 2020, and 2015-2020 DGA – suggest environmental intervention as the most effective strategy for improving dietary habits and weight status of a population.[8, 30, 55, 66, 79, 80] According to the SCT and TPB, this impact likely occurs through the influences of environment on personal and behavioral factors that also influence behavior.[48-50] In addition, environmental interventions have the ability to reach larger groups of people than individual interventions and are also more cost effective and more likely to lead to overall sustainable changes through a systems-wide approach.[80-82] However, before large system-wide policy can be implemented, evidence on the success of different strategies for improving the diet and weight of college students at the lower levels of influence, and on a smaller scale, should be proven.

To improve dietary behavior of college students, the campus environment, which largely influences dietary habits of college students, should be made conducive to individuals practicing healthy behaviors.[48, 58, 83] Specifically, focusing on environmental interventions to improve both the actual and perceived barriers to healthy eating may impact dietary behavior through interactions with personal and behavioral factors, which should also be considered and measured.[83, 84] The ultimate hope is that introducing effective positive environmental change in the college campus environment will result in system wide policy change that can facilitate sustainable improvement of dietary intake and weight status of the college population.[83, 85]

Utilizing the Marketing Mix in Campus Environment Interventions

One common way to introduce environmental change in a way that can subsequently influence consumer choice is through the practice of marketing. Marketing can be defined as the change in product offering to better meet the wants or needs of consumers.[86] According to Frederiksen, Solomon, and Brehony, marketing can be used to meet the health wants or needs of consumers by using techniques that encourage health-related behavior change.[87] Additionally, the use of marketing research is one method for assessing and incorporating the personal factors related to the environment that may influence behavior.[88] Marketing research aims to go beyond just describing an individuals' behavior to better understand complex personal motivations for behaviors to effectively promote a desired behavior.[89]

One way to promote health and to encourage positive dietary behavior change is by applying McCarthy's strategy for marketing products using the marketing mix four p's of place, product, price, and promotion.[86] These four aspects each address the most common actual and perceived environmental barriers to healthy eating identified by college students (Figure A.2).[84] Specifically, vending machines are *places* within the college campus environment where students often purchase snack food items due to common barriers of lack of time or need for convenience.[90-93] Introducing healthy snack *products* into vending machines is a way to improve the perceived and actual barriers of low availability of healthy options on campus.[94, 95] Changes to the *price* of healthy vending products addresses the common barrier of higher prices for healthy items.[71-74, 92, 96] Adding health-related *promotions* to a vending machine can provide individuals with nutrition information, which addresses the identified barrier of lack of information or knowledge by making it easier to identify and purchase healthy products.[72-74]

The potential impacts of using vending intervention strategies that focus on factors related to the marketing mix 4 p's can be described using a logic model developed by Liberato, Bailie, and Brimblecombe (Figure A.3).[84] This logic model aligns with the SCT and TPB in that it describes how making positive changes to the environment by improving the common barriers to healthy eating leads to a desired outcome through its influence on personal and behavioral factors that predict behavior.[48-50] Particularly, using these strategies on their own on in combination would ideally lead to *immediate changes* in theoretical personal factors or perceptions related to the previously discussed environmental barriers to healthy eating, including increased availability, affordability, and knowledge. This change would then influence behavioral *intermediary outcomes* including the increased purchase and intake of healthier food items. Ultimately, these changes in perceptions and behaviors would then ideally stimulate overall improved *health outcomes* and weight status in the long-term.

Place

The frequent unhealthy snacking behavior of college students warrants investigation into *places* within the college campus environment where college students frequently purchase snack food items.[17, 35, 47] Over half of college students purchase snack items from vending machines at

least once a week, with those that commonly use vending machines purchasing items approximately three to four days per week, on average.[27, 65, 93] College students indicate the most common reason for purchasing snack items from vending machines is the convenience or easy accessibility.[90, 92] Students surveyed at one large university indicated vending machines aren't usually the preferred choice for food, but they are usually the most convenient or readily available.[92] One study found during the daytime, vending machines were the only source of food within one-half of a mile for 22 percent of buildings on one university campus, with this proportion increasing to 89 percent in the evenings.[97] Furthermore, while a large majority of college students use vending machines to purchase snack items,[27] some students indicate the reason for purchasing items from vending machines is to replace a meal.[92, 98, 99] Environmental interventions that focus on improving healthfulness of sites considered to be large sources of food in limited access environments have been shown to have a large effect on dietary choices of targeted individuals.[79]

The high use and accessibility of vending machines for individuals in the college setting stresses the importance of having healthy options available in these food venues.[100] However, when using the Nutrition Environmental Measures Survey for Vending (NEMS-V) criteria, the university setting had the lowest percentage of healthy options of four worksite settings, with an average of only 8.8 percent of items being considered 'healthy', compared to 15.2 percent and 16 percent considered healthy in a county government office and manufacturing companies, respectively.[99] Other studies have found similar low levels of available healthful options using the NEMS-V criteria, with an average of 2.7 to 6.7 percent of all vending items considered healthy at some universities.[97, 101] Research indicates a majority of vending items on college campuses are high in calories, sugar, fat, and saturated fat and low in fiber.[27, 102-104] Byrd-Bredbenner et al., when evaluating the nutritional value of vending machine items in 78 buildings on 11 university campuses, found vending snacks provided an average of 200 calories per selection, with only 33 percent of the items meeting the criteria for "low-fat" or "low calorie".[102] In addition, Hoerr and Louden found only 4 of the 133 total snack options (3%) at one large university to be of high nutrient quality, meaning the snack provided a higher proportion of nutrients to calories.[105] The unhealthy nature of vending machines on college campuses may be related to the lack of established nutritional standards for vending items commonly found in primary and secondary schools.[101] Vending machine customers recognize the unhealthy nature of vending machines, often associating these machines as being a source of junk food or contributing to their weight gain.[26, 106] Sowers et al. found college students' perceived healthfulness of vending machines on eight university campuses in the U.S. to be the lowest of all of the campus food venues, with an average score of only 2.90 (± 2.72) out of a possible 12 points compared to 13.37 (± 4.65) out of a possible 20 points for the healthfulness of other campus food venues such as dining and restaurants.[107] Another study by Carrad et al. reported 92.5 percent of college students surveyed categorized 87.5 percent of the current vending machine options on their campus as 'too unhealthy.'[94] Furthermore, reports for the vending industry indicate the largely processed and low nutrient density of vending products has led to decreased vending sales of 2.9% annually as health-related attitudes among consumers increase.[108] These results suggest the need for interventions to improve availability of healthy options in vending machines on college campuses. Outcomes from these interventions may then be useful in advocating for implementation of system-wide vending machine policies in the university setting.

The actual and perceived unhealthy nature of vending machines on college campuses is important because, according to the SCT and TPB, they can influence individual dietary behaviors.[58, 78, 100] Park and Papadaki found the availability of vending snack machines on one college campus was significantly associated with higher frequency of snack purchases, with those individuals who purchased items from the vending machines having a significantly higher

consumption of high calorie snacks.[27] In another study by Caruso, Klein, and Kaye, college students chose the least healthy vending choices 59 percent of the time.[93] Therefore, dietary choices may be due to factors beyond the higher proportion of unhealthy items available and may include personal factors such as the perception that vending machines only offering unhealthy items, or their need to fulfill personal taste preferences or cravings.[48, 58] College students' frequent consumption from vending machines and poor dietary choices are important because they can lead to weight gain in the short or long term.[17] One study found a significant relationship between higher frequencies of vending usage and body mass index (BMI), an indicator of weight status, in the college population, with those using vending machines most often having a 4.5 times greater odds of being overweight or obese.[109] In addition, another study indicated a significant association between college students choosing less healthy vending machine items and a higher BMI.[110]

The vending environment is appropriate place to implement and test an environmental intervention focused on improving the dietary habits of college students by improving the accessibility and availability of healthy snack food items commonly consumed by this population.[83] The key measures typically used in vending machine interventions are often related to the identified barriers and facilitators to healthy eating in the college campus environment. Particularly, vending interventions commonly focus on the availability of healthy foods, pricing, and point-of-purchase nutrition promotions, as discussed below.[79, 83, 100, 111]

Product

One way to support healthy dietary behaviors in a population is to ensure healthy *products* are available and accessible within the surrounding environment.[8, 112] College students have suggested eating healthy snacks is important to them,[99] but a majority of college students are not satisfied with current vending snack options available at their university, with many indicating this is due to the limited healthy options available.[27, 90, 94, 99, 113] College students often indicate a desire for increased availability of healthy vending options, stating it would help them to consume more healthful snacks and increase how often they use vending machines.[90, 92, 96, 99, 113, 114] In addition, analysis of the vending industry suggests a change in product mix to include healthier options helped vending companies increased demand from new customers.[108] Therefore, the availability of healthy options in vending machines is an important factor to consider when designing dietary environmental interventions in this setting.

Though there are many studies assessing the availability of healthy vending options on a college campus,[27, 102, 105] there is limited research on interventions focused solely on increasing the availability of healthy vending items in the college setting.[100] One of the few studies that utilized this strategy with the college population, conducted by Hoerr and Louden, changed the availability of snack items categorized as high, moderate, and low nutrient quality from 12, 38, and 50 percent to 28, 38, and 25 percent of items offered, respectively, in a sample of four vending machines.[105] After the increased availability of healthy items, total vending sales for the four vending machines decreased to 86% of sales from the previous year, despite a campus-wide increase in total vending sales during the same time period.[105] This noted decrease in number of items sold brings another common issue of potential profit loss when replacing higher selling, less healthy items with healthier items that do not have the same level of proven sales volume.[115] The potential loss of profit is a common concern with increasing availability of healthy items, especially since research shows healthier vending items result in only half of the profit as other, less healthy options.[96, 115] The ideal level of change towards healthier vending items, or the number of less healthy items replaced with healthier items, for an intervention that would promote change without disrupting profits is also unclear. One study in the high school setting by Callaghan, Mandich, and He found replacing half of the vending options in all vending machines was associated with a significant

decrease in revenues.[96] Another study by Lapp, Ressler and Frith found when they replaced all of the items in just two vending machines on a college campus with healthier options, sales from those two machines remained steady from pre to post-intervention while vending sales across the entire campus declined.[116] However, it should be noted sales were measured using self-reported purchases rather than actual sales data, which could affect the validity of results.[116] With this and the previously mentioned study, it may have been useful to measure success by also collecting additional outcome measures other than sales, since sales is not a clear indication of dietary behavior.[95, 117] For example, a vending intervention by Gorton, Carter, Cvjetan, and NiMhurchu focused on increasing availability of healthy vending items in a hospital setting found the healthfulness of purchases increased with a reduction in calories (-24%), sugar (-30%), fat (-32%), and saturated fat (-41%) purchased per 100 grams of product sold.[118] Additionally, the study found total vending sales, vending usage, and customer satisfaction were consistent from pre- to post-intervention.[118] Overall, the limited number of studies, with varying strategies for level of healthy product replacement, and variations in outcome measures used warrants further investigation of successful strategies to increase availability of healthy vending options on a college campus without disrupting profit margins.

To improve the potential success of interventions that increase availability of healthy vending items, it may be beneficial to first gather students' opinions on what they consider important when purchasing or selecting products from vending machines. This aligns with the SCT in that personal factors, such as preferences and motivations, are important predictors of behavior and should be taken into consideration in addition to any environmental factors.[48, 81, 84] Though the healthfulness of snack foods is commonly mentioned as an important influential factor for food selection from vending machines in this population,[74, 92, 94, 114, 119] there are other factors that also need to be considered. Similar to other identified barriers to healthy eating among college students, cost and convenience also play roles in food choices from vending machines.[74, 91, 93, 94, 114, 119] Additionally, college students' most commonly identified influential factors when making a snack choice from a vending machine include taste, hunger, and cravings.[74, 92-94, 110, 114, 119] Some research indicates college students value taste or cravings over health when purchasing items from vending machines, because their need for a treat or reward from a less healthy item outweighs their awareness of the potential health benefits of a healthier option.[92, 106] However, Lapp, Ressler, and Frith found college students' perception of taste or convenience was not compromised by their perceived healthfulness of a vending item.[116] Furthermore, many students indicate there is a dual concern for the nutrition and taste of healthy food items, which is not usually considered when implementing vending interventions.[72, 79] College students also suggest they value individual choice, meaning though they want increased availability of healthy options, they don't necessarily want restrictions to unhealthy foods.[91] Therefore, introducing a moderate number of healthy products in a vending machine intervention may be a better option to direct consumers towards healthier options without restricting personal choice.[117] Finally, college students have indicated introduction of new or unique healthy items might further influence them to change their usual vending snack purchases.[92, 119] All of these persuasive factors should be taken into consideration when designing a vending intervention in the college setting to improve the potential acceptability of a product and success of an intervention.

One potential new and unique healthy vending item that can help improve the dietary intake of college students is a bean snack product. As previously mentioned, college students do not eat the recommended amounts of vegetable servings, which could lead to nutrient deficiencies, potential weight gain, and risk of disease.[4, 10, 30] In addition, the 2015 DGA suggest that a healthy eating pattern includes eating foods from all of the vegetable groups, including beans and legumes.[30] However, Sowers, Colby, Allison, and Zhou found more than 40 percent of college

students surveyed did not consume the recommended amounts of beans or legumes,[120] with the average intake being only 40 percent of the recommendations.[30, 34] Bean snack products are a good option for a healthy vending item because they are underutilized, low-cost products that are excellent sources of protein, fiber, folate, potassium, magnesium, iron, and zinc while also being low in saturated fat.[121-124] This type of healthy snack product is especially ideal since college students' diets have been shown to be deficient in fiber, folate, and magnesium, and excessive in saturated fat.[34] Furthermore, this nutrient content is different from items usually found in vending machines, with Byrd-Bredbenner et al. finding the average macronutrient composition of vending machine items was only 6 percent protein while only 10 percent of item met the "high fiber" health criteria.[102] In terms of health benefits, studies indicate college-aged students who consumed higher amounts of bean and bean products had higher bone density, a lower BMI, and lower blood pressure compared to those who did not consume beans.[34, 125, 126] In addition, individuals in one study who consumed beans had a significant 23 percent reduced risk of increasing their waist size and significant 22 percent reduced risk of becoming obese when compared to non-consumers.[126] Therefore, bean snack products meet the nutritional criteria necessary to help college students meet their recommended dietary needs and produce health benefits related to weight and risk of disease.

A bean snack product also seems to meet students' desires by increasing availability of a healthy item while balancing their priorities of dietary choice. Preliminary studies by Sowers et al. found 60 percent of college students interviewed perceived limited to no availability of beans on campus, with 30 percent of students wanting more beans available on campus in quick and convenient ways.[120] This product is also desirable among this population, with 56 percent of college students surveyed indicating they like or strongly like beans.[120] The product also balances the commonly identified priorities of taste and health, with 60 percent of students describing beans as "good" or "nutritious."[120] In addition, 46 and 41 percent of students surveyed identified taste and health, respectively, as reasons for their consuming beans.[120] These preliminary research results indicating this product might be desirable for college students increases the likelihood of potential success if used as part of a vending intervention, but more testing is needed to determine actual suitability among students.

Though a bean snack product seems to be an ideal and desirable healthy snack option for vending machines, the lack of current research on this new, unique vending product warrants further investigation of college students' acceptability and opinions of this product before implementing it as part of an intervention. Particularly, many institutions do not believe their consumers want healthy options, and are unwilling to implement healthy changes to vending machines until they are provided with evidence that suggests otherwise.[127] Including previously used strategies of focus groups or in-depth interviews to gather information from potential customers regarding their liking, preferences, or other influential factors, may help to provide evidence to estimate potential success.[128] Another common concern associated with the decision to implement vending interventions is the fiscal or structural constraints of the institution.[91] Many institutions are hesitant to implement change because of the large risk associated with potential profit loss by replacing popular items with items of unknown popularity, as seen with the Hoerr and Louden study.[105] One way to prevent this concern is to use a strategy suggested by Pohlmeier, Reed, Boyler, and Harp, which indicated college students desire to sample healthy foods before they are implemented, with their feedback used to further increase the potential for success.[113] If the suggested preliminary measures are taken into consideration, use of this novel product might be a viable way to improve the accessibility of healthy vending items while also improving the dietary intake and weight status of the college population.

Price

The *price* or *cost* of vending machine items has also been commonly mentioned as a determinant of snack choice from vending machines.[91, 106, 119] Specifically, over half of the students in one study considered the items in vending machines on their campus to be too expensive.[27] In addition, college students indicate if they are debating between two vending snack choices, they will usually choose the less expensive item.[92] The heavy influence of price commonly mentioned in this population, seems to outweigh many other influencing factors mentioned. For example, though eating healthy snacks is important to college students, they aren't necessarily willing to pay more for healthier options.[99] Carrad et al. indicate 47 percent of college students surveyed were willing to pay the same amount for healthy items as compared to unhealthy items while 32 percent were willing to pay more for healthy items.[94] This may be because college students often consider healthier items to be more expensive, with less value, which lowers their potential to purchase those items.[96] However, college students in other studies indicated they would change their usual vending snack purchases to purchase a new item if that item were introduced at a lower price relative to the cost of similar items.[92, 129] This is consistent with the law of demand, which states, all other things held constant, if the price of an item is decreased, the quantity of that item demanded will increase, and vice versa.[130]

Interventions that focus specifically on price reduction strategies for healthier vending options have resulted in increased sales of those items in a variety of settings.[129] For example, French et al. added low-fat snacks to 55 vending machines in secondary schools and worksites, while also introducing four pricing levels of equal price, 10 percent reduction, 25 percent reduction, and 50 percent reduction.[131] Each price reduction level was associated with a significant increase in purchase of the low-fat snack product, with a 9 percent, 39 percent, and 93 percent increase in sales of low-fat items, respectively.[131] Additionally, the average profits in each machine were not affected because the larger volume of lower priced items sold offset the price reduction.[131] In another study by French et al. conducted in bus garages, increasing availability of healthy items in vending machines by 50 percent while also lowering prices of these items by an average of 31 percent, resulted in a 10 to 42 percent increase in sales of the targeted items.[132] Specifically, healthy items comprised an average of 55 percent of the total sales in the intervention garages, compared to 19 percent of total sales in the control garage.[132] However, there was no significant difference in the self-reported overall dietary behaviors in this study, including intake of sugar-sweetened beverages, snack foods, and fruits/vegetables, among users of the intervention or control vending machines from pre- to post-intervention.[132] One of the only known examples of pricing interventions in the college population is also by French et al., which introduced a 50% price reduction strategy for healthier, low-fat snack items in nine vending machines in four different sites at a large university.[133] The results indicated a significant increase in purchases of the targeted items from 26 percent of sales at baseline to 46 percent after the intervention.[133] However, the increased sales volume of the low-fat product did not offset the low price, with the intervention resulting in a net profit loss.[133] The level of price reduction is often of concern when introducing this intervention strategy, with more research needed on what level of reduction is feasible to promote sales without decreasing the profit margin beyond profitability.[91] Additionally, the combination of pricing strategies with increased availability of healthy items in many of these studies makes it difficult to determine the individual influence of the price reduction. Hua et al. provides the only study in the college setting that tested individual and combination strategies, indicating a 25% price reduction for healthy vending items was not associated with a significant change in sales or revenue on its own or when interacting with other strategies.[134] Overall, more evidence is needed on the success of pricing intervention strategies in the college setting before a conclusion on the best practices can be made.

Though current pricing intervention studies indicate price decreases can increase sales of healthier items initially, more research is needed to determine the exact level of price change needed to produce change without impacting overall revenues.[91, 130] Similar to determining the product aspects of a vending intervention, it may be beneficial to gather information regarding pricing perceptions of potential consumers related to influential pricing levels prior to implementation.[96] This practice is not usually done, with a review by Matthews and Horacek finding only 9 percent of studies reviewed (n=2) evaluated the consumer perception regarding the price of healthy or unhealthy foods in vending machines.[100] In addition, most studies implemented pricing reductions, but no studies tested pricing increases for healthier options, as some individuals may value the items more if they are more expensive.[94] It is also unclear if the initial changes in purchasing behavior associated with price decreases are sustained after the intervention period.[117] Overall more research is needed, in the college population specifically, to test multiple aspects of vending pricing strategies before an ideal intervention can be recommended.[130]

Promotion

One of the main facilitators to encouraging healthy eating through environmental change is to provide nutrition information to consumers using *promotions* at the point-of-purchase.[84, 111, 135] Glanz, Bader and Iyer have identified multiple strategies to increase sales of healthy items, including increasing availability and pricing incentives as previously mentioned, but consider providing promotional information to be one of the most successful.[117] College students have often indicated their desire for labeling of healthy foods or providing health information on or near vending machines, stating it would influence their purchasing of healthier items.[90, 92, 113] According to Sonnenberg et al., even consumers who consider themselves to be health-conscious often mistake unhealthy choices as being healthy, but were able to better identify and prefer healthier items when they were accompanied by simple nutrition information.[136] However, the design of vending machines often does not allow for easy display of individual product nutrition information before the point-of-purchase.[137] To overcome this barrier, a variety of healthy vending promotional strategies have been used as part of vending interventions. The most common strategies include providing specific nutrient information, labeling foods by levels of healthfulness, labels identifying healthier choices based on certain health-related criteria, and posters encouraging healthy eating or product promotion.

The first promotional technique of providing individual product nutrition information at the point-of-purchase has been identified as a major tool to influence product knowledge and consumption as well as behavior change towards positive dietary habits.[100, 135] There are a variety of different types of nutrition information that can be provided at the point-of-purchase, including calorie content, nutrients, or a combination of the two. Providing caloric information to college students at the point-of-purchase in dining settings has been shown to significantly influence their intention to purchase an item,[138] with 33 and 10 percent of students indicating they sometimes or always changed their choice of food based on calorie information provided.[139] Hammond et al. also found availability of caloric information in dining settings significantly decreased the amount of calories purchased and consumed by college students.[140] However, very little research has been conducted using this technique in vending machines with the college population. The only known study using this method by Platkin, Kelvin, and Yeh tested the impact of three strategies for providing calorie information for campus vending machine items – calorie information only, exercise equivalents only, and calorie information plus exercise equivalents – on types of snack items sold and amount of calories purchased.[137] None of the intervention conditions resulted in a significant difference in the number of items sold in any snack category when compared to baseline, though the amount of calories purchased with each condition decreased more in the

intervention groups (16 and 14 percent less in the calorie only and calorie plus exercise equivalents groups, respectively) compared to the control groups (2 percent less).[137] These studies suggest while college students' dietary choices may be influenced by caloric information at the point-of-purchase in other settings, more evidence is needed to determine if this influence applies to vending machine snack purchases.

Interventions in the college campus environment that used promotions to provide calorie along with specific nutrient information have shown mixed results in terms of success. A study by Larson-Brown labeled all vending items on a college campus with nutrient fact cards to determine the effect on vending sales of healthy products, identified as those containing higher proportions of nutrients than empty calories.[141] The labels provided energy content and bar graphs with the percentage of the recommended dietary allowances (RDA) for specific nutrients determined by student interest or deficient intake, including protein, calcium, thiamin, vitamin C, and iron.[141] The percentage of total sales contributed by healthy items significantly increased with the intervention from 49.8 to 53.7 percent.[141] The previously described study by Hoerr and Louden provided similar nutrition information for vending machine products on a college campus, including calories per serving and percent of the RDA for protein, vitamin A, vitamin C, thiamin, riboflavin, niacin, calcium, and iron in a bar graph format.[105] This intervention also saw increased total sales from the first intervention period that just increased availability of healthy products, but only to 92 percent of the baseline measurement.[105] Though sales increased, it is unclear if this intervention accomplished its purpose of increasing sales of healthy items since the sales with this intervention were primarily for the least nutrient-dense items offered in the vending machines.[105] These interventions might increase their influence if they changed the type of information presented to consumers. According to van't Riet, point-of-purchase nutrient information for products in grocery stores were more likely to influence consumer purchase if they provided unhealthy nutrient information rather than, or in addition to, healthy nutrient information.[142] Research from Kozup, Creyer, and Burton also found providing unhealthy nutrition facts of fat, saturated fat, and cholesterol to consumers on packaging and menus was significantly associated with consumers' attitude towards the product, overall nutrition attitude, purchase intentions, perceived credibility of the information, and lower risk of heart disease and stroke.[143] However, more information is needed to determine what types of product nutrition information, specifically in vending machines, is likely to influence purchasing behaviors of college students.

The second commonly used promotional strategy includes categorizing foods by levels of healthfulness. The most frequent labeling technique within this strategy uses a three level traffic light system with categorization similar to the NEMS-V criteria of green, yellow, and red labels assigned to the most healthy, moderately healthy, and least healthy items, respectively.[65] A study by Carrad et al., found college students were significantly more likely to identify four out of five healthier options from pairs of vending items when the items were labeled using a traffic light labeling system.[94] A similar study by Sonnenberg et al. suggested individuals who notice and are able to appropriately use traffic light labels to identify healthier choices were significantly more likely to purchase those healthier items.[136] Brown, Flint, and Fuqua specifically tested the effect of a traffic light labeling strategy on sales of different vending items on a college campus.[144] The items were labeled either red (high), yellow (moderate), or green (low) according to their calories per serving, percent calories from fat, and percent calories from saturated fat.[144] After the intervention, there was a 4.84 and 15.21 percent decrease in sales of red- and yellow-labeled items, respectively, and a significant 50.76 percent increase in green-labeled items.[144] In addition, use of the traffic label to promote healthy items did not result in overall reduced profits, but actually increased sales by 2.41 percent, or 75 items, compared to baseline.[144] These results are similar to those found in other settings with Thorndike, Riis, Sonnenberg, and Levy indicating the use of a

traffic light labeling system in a hospital cafeteria resulted in significant decreases in the sale of red 'unhealthy' items (24% vs. 20%) and significant increases in the sale of green healthy items (41% vs. 46%) after 24 months.[145] This change in sales was also able to be sustained long-term, over a two year period, without decreasing the overall profitability.[145] Though the traffic light system seems to be successful in increasing recognition and purchase of healthy items in the college population, more information is needed to verify this success as well as determine the potential for sustainability.

Using labels to identify healthy food based on predetermined criteria is also a common strategy used with vending machine interventions, usually in combination with other techniques. The previously mentioned study by French et al., which reduced the price of low-fat snacks by 50 percent in college campus vending machines, also used orange labels to identify the low-fat items.[133] Though this study did see an increase in sales of low-fat items with the intervention, it is unclear whether this was due to the pricing or promotional strategies, since they were implemented simultaneously.[133] Wilbur, Zifferblatt and Pinsky also tested the effects of healthy promotional labels in a worksite setting by evaluating two machines that increased availability of healthy items, two machines that increased availability of healthy items and included healthy product labels, and two machines that increased availability and then included healthy product labels three months after the start of the study.[146] Including promotional techniques in addition to just increasing availability of healthy vending items in the worksite setting was associated with a significantly higher proportion of sales from the targeted healthy product when compared to just increasing availability (45% vs. 40%).[146] Though these combined techniques seem to be successful, more research is needed to confirm these results and test other combination strategies. In addition, the lack of evidence regarding simple labeling of healthy options in vending machines in the college population, without being combined with other strategies, warrants further investigation to determine the individual effect of this strategy.

Interventions that have been most successful at influencing purchasing decisions of consumers with point-of-purchase health information were those that included multiple promotional components rather than just a single strategy.[142] Particularly, including motivational signage with health information or encouraging consumption of a targeted product along with healthy product labels may increase a promotions influence beyond using the labels alone. These types of motivational, healthy vending signs were the most popular among college students in one study with 34 percent of students noticing the signs and 43 percent of students who noticed the signs indicating they influenced their purchasing decisions.[96, 99] French et al. tested the effectiveness of promotional signs for low-fat snacks in vending machines in secondary schools and worksites with the three conditions of no labels, low-fat labels, and low-fat labels plus a promotional sign encouraging consumption of low-fat items.[131] Only the labels plus promotional sign condition was found to be independently and significantly associated with increased sales of the targeted product.[131] Bergen and Yeh conducted a similar study in beverage vending machines on a college campus by randomly assigning eight vending machines to one of three conditions, including two interventions and a control.[147] Intervention I identified healthy beverage options (water and diet beverages) with brightly colored labels reading '0 calorie, 0 carb' while intervention II included these labels plus an educational poster describing potential weight gain associated with intake of higher calorie beverages.[147] Intervention II was associated with a significantly higher increase in sales of healthy beverage options compared to intervention I.[147] Furthermore, revenue from the beverage vending machines increased by 25 percent, with 71 percent of the increase attributed to increased sales of healthy beverages.[147] In another study by Fiske and Cullen with vending machines in teacher's lounges, adding low-fat labels plus promotional posters encouraging low-fat selections resulted in higher average sales of low-fat

items per week compared to simply increasing the availability of low-fat items and using low-fat labels (3.2 vs. 2.6), though these results failed to reach significance.[148] Another study by Dingman et al., labeled healthy options in vending machines on a college campus with 'BC' for 'better choices,' while also including an informational poster with a nutrition facts label explaining the promotion.[149] As an additional part of the promotion, researchers sent a promotional e-mail explaining the promotion to students residing in the dorm where the intervention was taking place.[149] The results indicated no significant difference in the proportion of snacks labeled 'BC' sold or the average number of calories sold from pre to post-intervention in the intervention compared to control group.[149] These results suggest the use of motivational posters encouraging intake of targeted healthy vending options used in combination with labels identifying the healthy options may be more influential than just providing labels alone in other settings, with more evidence needed in the college population.

Overall, current research provides mixed results regarding success of using vending machine promotions to encourage healthy item choices in the college campus environment. According to Cowburn and Stockley, though consumers often report high use of nutrition information and labels when making food purchasing decisions, the actual use of these promotions may be lower.[150] The SCT offers the explanation of the potential effectiveness of health promotions relying heavily on the personal ideas, beliefs, and knowledge of the targeted consumers.[57, 58, 86] For example, a consumers' ability to appropriately understand the nutrition information provided to them will largely impact their likelihood of utilizing the information.[142, 150, 151] Some believe the average consumers' understanding can be enhanced by only including simple numbers, including reference values for recommendations and total diet, visual explanations, and consistent descriptions for easy comparison between products.[150, 151] Another personal aspect that might influence the use of promotions is an individual's health beliefs, including what information they value when making decisions about health.[100, 152] For example, some individuals value information on certain food categories, some want specific nutrient information or content, and others want simple healthy food labels based on predetermined nutrient criteria.[153] The understanding and interpretation of the healthfulness of a food item can also be influenced by different social demographics such as age, gender, cultural background, and socioeconomic background, among others.[100, 135] With multiple choices for promotion, limited or mixed results, and potential influence of population characteristics, it may be beneficial to test various strategies with the target population to gather their perceptions before implementation.[96] Overall, more information is needed on the best ways to facilitate healthy eating through providing nutrition information with the specific and unique setting of vending machines.

Limitations of Current Research

One large limitation of the reviewed research is the lack of substantial and consistent evidence demonstrating the success of any one particular vending machine intervention strategy for use in the college population. This lack of evidence can lead to potential barriers of future intervention implementation due to concerns related to consumers lacking the desire to eat healthy, potential reduction in sales or profitability, or lack of available resources.[91, 115, 127] To overcome these barriers, more research is needed to correct the deficiency of evidential success.

The limited success of many of the reviewed vending intervention strategies could be related to researchers focusing solely on the environmental influences of behavior without also considering the personal factors that might influence behavioral change.[48, 86] An individual's personal ideas regarding reasons for making choices from vending machines, the appropriate price point at which they value an item, and their beliefs or ability to utilize health promotion techniques all have potential influence on their behaviors, and consequently the success of an intervention.[91-

[93, 99, 114, 119] However, none of the interventions mentioned collecting or taking into consideration the attitudes and opinions of individuals in the target market, which could influence interventions' influence.[100, 135, 154] One way to control for these personal variables and increase prospective success is to include marketing research strategies for gathering preliminary consumer insights using focus groups, taste testing, and interviews with the target population and constructively incorporated into an intervention.[88, 89, 96, 113, 128] Only one study in a hospital setting used preliminary data collection to dictate aspects of a vending intervention,[128] while other studies just gathered personal characteristics but did not utilize them to improve intervention strategies.[92, 93, 96] Ultimately, including the thoughts, ideas, and concerns of the target population throughout the intervention process can lead to a more informed vending intervention and improve potential success, which can then positively contribute to available research in this area.[88, 89]

Another reason for the lack of clear evidence for effective vending strategies is the weaker study designs or methodology common to environmental interventions.[84, 117] Though utilizing the four "p's" of the marketing mix provide a comprehensive framework to address existing barriers to healthy eating using vending machine interventions, these aspects are often used in combination, rather than exclusively, making it difficult to determine the effectiveness of each individual techique.[79, 117] Interventions in a variety of settings have also combined availability and price,[132] availability and promotion,[128] or availability, price, and promotion[133, 154] implemented simultaneously. There are also some strategies that use multiple or overlapping techniques within the same type of strategy, such as those promotions using labels and posters.[147-149, 154] Many vending interventions also made large changes to their availability by changing multiple items in the machines, which not only introduces risk of potential profit loss by replacing many high selling items with healthy, less proven options, but it also makes it unclear which specific product influenced the behavioral change.[105, 116, 146, 148] This is especially important if new and unique products are introduced into vending machines, where is it important to not only measure personal ideas, opinions, and acceptability of these items, but also individual-level evidence for success. Glanz, Bader, and Iyer suggest implementing a small to moderate number of changes in availability may better direct consumers towards the healthier options while not restricting personal choice, increase the ability to determine individual product influence, and also reduce the risk of potential profit loss associated with large changes in new product availability.[117] One option for testing individual strategy effects is the use of multiple, comparable vending machines each having a different technique, as seen with Wilbur et al. and Bergen and Yeh.[146, 147] However, extraneous differences between the machines – including location, sales traffic, and common customer demographics – would need to be tested and controlled to prevent potential influence of results. Though the use of environmental interventions poses some likely limitations or weaknesses, more comprehensive and rigorous study designs should be used to strengthen the potential evidence in this area.

Another limitation of environmental change research is that it often only measures sales, rather than actual behavior change or personal factors related to behavior change, making it difficult to determine true success.[95, 117] Though the commonly used measure of sales might provide an idea of behavior, it is not a clear indication that dietary behavior changed just because purchasing of those items was increased.[95, 117] Furthermore, individual purchasing behaviors are not usually measured, but rather the measurements are of total sales, making it unclear whether the intervention changed behaviors of previous customers or if it attracted new customers.[95, 131] Some researchers also suggest environmental interventions may indirectly influence behavior change by providing a supportive environment that makes it easier to make healthy choices, but more research is needed to support this idea.[59, 132] For example, while point-of-purchase nutrition information has been shown to increase consumer awareness and possibly understanding of a

food's nutritional value, there is little evidence available as to whether it has a direct influence on changes in purchasing behavior.[95, 128] This concept aligns with the TPB and PBC, which suggests measuring an individual's perceived barriers or facilitators to practicing a behavior could be a theoretical predictor of behavioral change.[58, 59] However, Van Hulst et al. found that while increasing availability of healthy items with a vending intervention improved the perception of healthy items available, there was no change in the participants' readiness to adopt a healthy lifestyle.[128] Furthermore, little research is available on actual changes in dietary behavior with vending interventions.[154] Only one known study by French et al. using food frequency questionnaires to measure changes in dietary quality before and after a vending intervention, but found no significant changes.[132] To overcome the difficulties with measuring success in environmental interventions, it may be helpful to collect a variety of different comparison measures, including individual purchases, perceptions, and actual dietary behavior.

Sustainability of environmental interventions introduced with research is another important issue that is not usually discussed.[79] One large concern is that interventions will result in initial positive effects, but that these effects will diminish with after initial implementation of an intervention.[117] For example, Glanz, Bader, and Iyer indicate pricing strategies will often result in initial purchasing increases as individuals try the product, but these higher sales are not usually sustained long-term.[117] However, Thorndike et al. found promotional techniques used in a cafeteria setting resulted in consistent changes over a two-year period.[145] Sustainability of intervention impact, including product sales, after the conclusion of an intervention period is also a concern.[92] French et al. provides an example of this concern with sales of a targeted intervention product largely decreasing after the intervention period of reduced prices, when the price increased back to the normal level. [92, 133] Overall, more information is needed to determine feasible strategies for vending machine interventions that will result in long-term, sustainable changes.

Summary of Current Research

The college population provides a unique opportunity to impact the health of a large number of individuals at a critical time period of exploration and development of lifestyle habits.[20, 21] Specifically, the unhealthy eating patterns, excessive energy intake, and large amounts of undesired weight gain common among college students warrant further investigation into potential interventions in this population.[4, 32-34] Focusing on the college campus environment present a particularly viable strategy due to the large influence of the environment on the dietary habits of college students.[11, 39, 62, 63] Environmental interventions also provide promising and cost-effective strategies to effectively influence the health behaviors of a large number of individuals.[46, 55, 68, 79-82] College students have identified a number of barriers to healthy eating present in the college campus environment, including lack of available healthy foods,[26, 70-72] higher cost of healthier items,[26, 71-74] lack of time or busy schedules leading to intake of unhealthy convenience items,[70-75] and lack of nutrition information or knowledge about what is considered to be healthy.[73-75] According to the SCT and TPB theories, environmental change interventions should focus on improving these identified perceived barriers to healthy eating to encourage positive behavioral change towards healthier dietary habits.[48, 49, 59]

McCarthy's marketing mix four "p's" of place, product, price, and promotion provide a comprehensive framework for environmental interventions, with each aspect addressing one of the identified barriers to healthy eating among college students.[86] Specifically, vending machines are *places* within the college campus environment frequented by many college students due to the convenience with accessing commonly consumed snack foods.[27, 65, 90, 92, 93] Vending machines also make an ideal intervention target because they address many of the previously identified barriers to healthy eating, including low availability of healthy food items, perceived higher cost for

healthier items, and lack of nutrition information at the point-of-purchase.[27, 90, 92, 93, 96, 102, 103, 106, 113] Increasing availability of healthy *products* in vending machines has been introduced in only a few studies in the college setting, with mixed results of increasing purchases of healthy items.[105, 116] To improve the potential for success, it may be beneficial to take into account the personal factors students consider when making purchasing decisions, including health and taste among other factors.[74, 92, 93, 99, 110, 114, 119] Introducing a bean snack product into vending machines seems to meet student desires for a new and unique product and more convenient availability of beans on campus, but more testing on the acceptability of this product is needed. The *price* of an item also seems to influence students' vending purchases with vending interventions in a variety of settings finding price reduction strategies for targeted healthy items resulted in increased sales of those items.[129, 132, 133, 154] However, more information is needed on the specific price reduction level that would elicit positive influence without negatively affecting overall profit margin. Finally, there are multiple different types of *promotional* strategies that have been tested with vending machine interventions including providing specific nutrient information, [94, 105, 137, 141] labeling foods by levels of healthfulness,[144, 155, 156] labels identifying healthier choices based on certain health-related criteria,[131, 133, 148, 149] and posters encouraging healthy eating or product promotion.[96, 131, 147, 148] These strategies have been largely successful in increasing the sale of targeted healthy items in vending machines in worksites and primary and secondary schools,[131, 147, 148, 156] but there have been mixed results with the college campus environment.[105, 133, 137, 141, 144, 149] The inconsistency in methods used and lack of substantial research available, specifically within the college setting, make it difficult to determine the most effective strategies for a vending intervention.[95]

Determining successful, tested environmental strategies is the first step to developing systems approach policy changes that can influence the health behaviors of a targeted population.[46, 55, 68, 79-82] However, the limitations of current research in the area of vending interventions in the college population should be addressed before environmental change can be accomplished. According to the SCT, personal factors, including individual attitudes and perceptions, also influence behavior and should be assessed and incorporated into an intervention.[48] In addition, various intervention strategies should be tested individually or controlled for to discern their individual or combination effects.[117] More consistent measures of actual behavior, as well as perceived healthfulness of the environment and actual dietary habits, should be evaluated in addition to sales to provide sufficient support for intervention impact.[59, 95, 117] Finally, efforts should be made to study and ensure the sustainability of any intervention that is implemented.[79] Overall, the goal should be to introduce more informed vending interventions that aims to improve the actual and perceived healthfulness of college campus environments as well as college students' dietary intake behaviors to eventually impact their weight management and overall health.

CHAPTER I:
Testing Product, Pricing, and Promotional Strategies for Vending Machine Interventions with a College Population

A version of this chapter has been submitted for publication by Morgan F. Sowers, Sarah Colby, Katie F. Kavanagh, Elizabeth Anderson Steeves, and Wenjun Zhou:

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As first author, I was the primary contributor to the identification of study purpose and objectives, conception and design of the study, planning and collection of data, analysis and interpretation of the data, writing and revision of the manuscript, and submission to publication. The co-authors, as professors overseeing my work as a doctoral student, provided critical guidance in study design conception and data analysis procedures, as well as substantial revision of critically important manuscript content. The work conducted with this paper was a part of formative research completed before the dissertation proposal process and thus it is not a formal component of the final dissertation project.

Abstract

Objective: This study used a multi-phase, multiple method design to gather both quantitative and qualitative data from participants regarding the product, pricing, and promotional strategies associated with a potential intervention for a healthful vending snack product. ***Methods:*** Cognitive interviews were conducted in two phases – Phase 1 (exploratory) and Phase 2 (confirmatory) with a convenience sample of 30 college students in each phase (60 total participants). In the exploratory phase, quantitative scores for liking and preference and qualitative explanations were collected for the product, price, and promotion options tested. The highest scoring products and promotions, and the most commonly mentioned prices in phase 1 were retested in phase 2. Data on vending usage were also obtained in both phases. ***Results:*** Participants' product opinion was most commonly related to taste. Participants' identified pricing levels were based on perceived healthfulness, affordability, and payment convenience. The highest scoring promotions were described as having simple, clear health information and a visually appealing design. The majority of participants surveyed (70%) indicated they would purchase the product if it were in the vending machines on campus. However, 60% of participants used vending machines less than once per month, with the most common reasons for vending use being hunger (38%), lack of time (30%), and convenience (30%) and the most common reasons for vending product choice being price (20%), health (20%), taste (15%), and cravings (15%). ***Conclusion:*** Success of vending interventions among college students may be improved by incorporating identified influential attributes for product, pricing, and promotional strategies.

Introduction

The unhealthy eating patterns, excessive energy intake with low nutrient content, and large amounts of undesired weight gain common among college students warrant further investigation into potential interventions to improve the health of this population.[11, 32] Focusing on the college campus environment presents a particularly viable strategy due to the large potential influence of the environment on the dietary habits of college students.[62] Particularly, if the campus environment is not conducive to or supportive of college students practicing healthy behaviors, it may be less likely for students to make healthy choices.[48, 58] Therefore, environmental change interventions should focus on improving identified barriers to healthy eating to encourage positive behavioral change towards healthier dietary habits among college students.[48, 58]

One common way to introduce environmental change in a way that can subsequently influence consumer choice is through the practice of marketing. According to Frederiksen, Solomon, and Brehony, marketing can be used to meet the health wants or needs of consumers by using techniques that encourage health-related behavior change.[87] Expanding on this concept, McCarthy's marketing mix describing the four "p's" of place, product, price, and promotion provides a comprehensive framework for environmental interventions, with each aspect addressing one of the commonly identified barriers to healthy eating among college students.[86]

Vending machines are *places* within the college campus environment that address the common barrier of lack of time or need for convenience [70-74] by providing convenient availability of snack foods and drinks.[27, 65, 90, 92, 93] Vending machines also make an ideal intervention target because they are often associated with many identified barriers to healthy eating in this population, including low availability of healthy food items.[70-72] Increasing availability of healthy *products* in vending machines has been introduced in only a few studies in the college campus setting, with mixed results in terms of increasing purchases of these healthy items.[105, 116] This lack of proven success may be due to these interventions not measuring or incorporating personal factors that may be considered when making purchasing decisions at vending machines, including the health, taste, and convenience of the product, among other factors.[74, 92, 93, 99, 110, 119] Furthermore, while students have indicated they would like new and unique healthy products introduced into vending machines,[92] there is a lack of evidence for methodology needed to test the acceptability of a new product before introduction to maximize potential success.

Another barrier to healthy eating present that can be addressed with a vending intervention is the higher cost of healthier items.[71-74]. The *price* of an item being an influential factor for purchasing explains why price reduction strategies for targeted healthy items used in vending interventions in a variety of settings resulted in increased sales of those items.[129, 133] However, more information is needed on the specific price reduction level that would elicit positive results without negatively affecting overall profit margin.

Finally, one of the main environmental barriers to healthy eating is the lack of nutrition information to help individuals identify healthy options. [27, 73, 74, 90, 92, 93, 96, 102, 113] Multiple healthy *promotion* strategies have been tested with vending machine interventions, with varying levels of success, including providing specific nutrient information,[94, 105, 137, 141] labeling foods by or with levels of specific health criteria,[131, 133, 144, 148, 149] and general promotions of product availability.[96, 131, 147, 148] The overall inconsistency in promotional methods used and lack of substantial research available in the college population make it difficult to determine the most effective approaches to use with a vending machine intervention.[95]

One way to improve potential success in this understudied population and setting is to conduct marketing research with college students on their opinions and attitudes towards specific product, price, and promotional techniques before implementing a vending intervention. According to the social cognitive theory (SCT), personal factors, such as the target populations' opinions and attitudes of different strategies as well as their consumer characteristics, also influence behavior and should be assessed and incorporated in an intervention strategy.[48] The use of marketing research in the college population is particularly important because research has shown that this population differs significantly from the general adult population regarding their opinions, ideas, and potential for influence of different marketing strategies.[157] Marketing research results can be used to test and refine strategies based on the target populations' opinions, reactions, and interpretations to frame what is being offered in a way that better meets their needs. [158, 159]

According to Glanz and Mullis, vending machines provide a convenient place to test environmental interventions focused specifically on marketing strategies improving product availability, pricing, and promotions.[83] However the current limited research for successful

vending interventions in this population and setting may be due to the lack of formative research needed to determine the most appropriate vending intervention strategy among college students. Therefore, the purpose of this study was to improve the lack of evidence regarding college students' personal opinions and attitudes towards marketing strategies to potentially improve potential success of future related vending interventions. The specific objectives of this study were to develop and utilize a methodology for assessing and applying student vending users' opinions of marketing strategies and determine the most liked, preferred, and influential *product, pricing, and promotional* strategies to inform a healthy vending intervention on a college campus.[158]

Materials and Methods

This study utilized multiple phases and multiple methods, with both qualitative and quantitative data, to gather comprehensive marketing insights on the specific phenomenon of vending machine usage among college students.[160] This study was conducted in two phases, an exploratory phase (Phase 1) and a confirmatory phase (Phase 2). The exploratory quantitative and qualitative data gathered with Phase 1 served to reveal participants' acceptability and opinions regarding preliminary marketing strategies. These data served to inform and narrow the strategies, which were then retested with confirmatory quantitative data collected in phase 2. Multiple methods are appropriate and commonly used with exploring complex phenomena with marketing research, including evaluating the personal opinions and reasons for influence of a vending intervention strategy in this study, as they provide varying levels of measurement that capture different aspects of the vending experience to provide a more holistic description.[161] Specifically, data collection in both phases used a concurrent triangulation strategy, which gathers both quantitative and qualitative data simultaneously, in an effort to confirm and corroborate the findings of one data collection technique with the other, and vice versa.[160, 161]

This study took place at a large university in the southeastern United States. The specific target population for this project included students attending the target university who utilized vending machines. An individual was eligible to participate in any part of this study if they were a student at the study university and at least 18 years of age. Students were also asked about their frequency of vending usage on a six-point scale adapted from previous studies in this population,[27, 62, 93, 99] with those that indicated the lowest vending usage level of "never or rarely" not considered vending users and therefore excluded from the study. Participants were also excluded if they had any food-related allergies, since the study required participants to consume the product to appropriately answer product-related survey questions. Finally, participants were excluded from phase 2 participation if they participated in phase 1 of the study to avoid potential testing or priming effect. The study included a convenience sample of 60 participants from the target population of college student vending users recruited from the campus library, with 30 participants (15 male and 15 female) in each phase.

Data were collected in both phases using individual cognitive interviews with participants from the target population. The cognitive interview questions were developed by a panel of content experts who conducted a literature search on marketing research questionnaires for food product items. Six student researchers (3 teams of 2) conducted the interviews in a common area of the campus library. Before data collection, student researchers attended a one-hour training session providing instruction on how to conduct qualitative interviews, ensuring familiarity with interview questions, and conducting mock interviews with the primary investigator.

The cognitive interview process consisted of six parts including screening, product, price, promotion, overall opinion, and demographic questions (Table B.1). The screening questions included the eligibility criteria previously mentioned. The remaining questions in phase 1 served as prompts, with an open-ended format, whereas the questions in phase 2 were provided in a

closed-answer, multiple-choice format, with the option for participants to provide qualitative comment. Demographic data collected with both phases included age, gender, race, academic year, academic major, and self-reported height and weight to calculate body mass index (BMI). These characteristics were included due to evidence indicating their potential associations with frequency of vending machine use and/or food choice and dietary habits in this population.[92, 109, 162-165] The demographic data was used for description of the overall sample and sample with each phase as well as statistical comparison of the samples with each phase to ensure there were no statistically significant differences.

A team of two student researchers conducted each interview, with one asking the interview questions and one transcribing participants' answers and recording detailed field notes using a form on the Qualtrics online survey platform.[158, 166] While participants' responses were not audio recorded, an effort was made to transcribe the responses verbatim, with researchers providing follow-up reflection to repeat back what they transcribed to participants to ensure data validity. Phase 1 interviews took approximately 20 to 30 minutes to complete while phase 2 interviews took approximately 15 to 20 minutes to complete. After completing either the phase 1 or phase 2 interview, participants were provided a $15 gift card.

The focus of the marketing strategies tested in this study was a healthier snack alternative proposed as part of a vending machine intervention. The specific healthful snack product tested was a seasoned dried fava bean snack product promoting the positive nutrition attributes of providing protein and fiber. Evaluation of the nutrition facts of this item indicated it was a "healthy" snack food item according to the Nutrition Environmental Measures Survey for Vending (NEMS-V) criteria,[65] which is based on the Dietary Guidelines for Americans 2015-2020.[30] The product came in four different flavor varieties, labeled for the purpose of this study as "sweet," "salty," "peppered," and "spicy." This product would be included in the vending machines in a one-ounce, individual serving size shaped to fit the usual vending slots. The promotions tested were five types of point-of-purchase signage that could be placed on the vending machines. The five types of promotions tested were based on previous research, which included "healthy item labels" (using the National Automatic Merchandising Association's FitPick labeling program),[167] "healthy item categories" (using the NEMS-V 'Mix It Up' promotions),[65, 168] "product nutrient information" (including amount of calories, fat, protein, and fiber per serving; a nutrition facts label; and a list of nutrients the product is a high source of),[169] "product health benefits" (including descriptions of benefits for weight and disease management as well as energy promotion), and "additional product information" (including pictures of the product package, general nutrient information with talking bean characters, general healthy marketing slogans, and consumer ratings and opinions of the product).[169]

Phase 1: Exploratory Phase Questions

For the product questions, participants were provided with four unpackaged and unlabeled 0.25-ounce samples, one at a time and in random order, each containing one of the four dried fava bean snack product flavors. The quantitative questions asked participants to provide their product liking score on a five-point Likert-type scale for each product (Table B.1). After sampling all of the product flavors, participants ranked their preference of the product flavors from least liked to most liked. Qualitative probing questions then asked participants to explain their rating and preference rankings as well as describe what would make them like the product more.

The price questions were presented in an open-ended format, with no set price options provided. Participants were asked to provide quantitative numbers for their perceived actual (price they thought the product was), expected (price they thought the product should be), and influential (price that would make them likely to purchase the product) prices. Similar to the product

questions, the participants were asked probing qualitative questions to determine reasons why they chose each price level.

For the promotion questions, participants were provided with the five examples of promotional strategies one at a time and in random order. The quantitative questions for promotions were similar to product questions, where participants provided a liking rating and a preference ranking. Participants were then asked to score the promotion influence by indicating if each promotion would make them want to purchase the product (yes, maybe, or no). Participants were also probed to provide qualitative explanations for their rating, preference, and influence scores. Finally, qualitative questions asked participants to provide their suggestions for improvement of each marketing strategy, and if they thought anything should be added, removed, or combined from the strategies.

An additional question asked participants if they would purchase the item if it were in the vending machines on campus in an attempt to measure behavioral intent.[159] Qualitative probing questions then asked participants to explain their answer as well as describe what would make them more likely to purchase the product. Participants were also to indicate their most common reasons for deciding to purchase items from vending machines and most common reasons for selecting items from vending machines on campus.

Data from phase 1 were analyzed using both quantitative and qualitative methods. The quantitative product liking and preference rating scores were totaled for all participants, with the two product flavors with the highest total scores retested in phase 2. The influential price amounts indicated by participants were compiled and analyzed using a boxplot graph to produce a standard (median), lower (lower quartile), and higher (upper quartile) price to be retested in phase 2. In addition, two one-sample t-tests were conducted to determine the mean difference between the perceived actual and expected prices as well as between the perceived actual and influential prices. The quantitative data from the promotion liking, preference, and influence scores from all 30 participants were totaled for each of the proposed promotional strategies to provide a total score, with the three promotion strategies with the highest total scores chosen for further testing in phase 2. The qualitative data from the product, promotion and overall opinion questions were compiled for each question and organized according to themes using QSR International's NVivo qualitative analysis software.[170] To ensure qualitative reliability, the lead researcher and one student researcher with experience in qualitative data analysis conducted intercoder agreement, with the goal of at least 80% agreement.[160, 161]

Phase 2: Confirmatory Phase Questions

The second phase retested the subset of product flavors and adapted price and promotional strategies from phase 1 with another group of 30 participants. In this phase, we created a situation similar to what students would experience at the vending machines by allowing participants to fairly evaluate pricing and promotional strategies before tasting the product. The three promotional and pricing strategies, followed by the two product flavors, were provided to participants one at a time and in random order.

The product and promotion liking rating and preference ranking questions were in the same format as phase 1. The influence score for the price and promotion options were evaluated by asking if that price or promotion would make the participant more likely, neutral, or less likely to purchase the product from campus vending machines. Similar to product and promotion, participants also ranked the pricing levels by which option would be most to least likely to influence their purchase. To determine if any further revisions should be made to promotions, informal qualitative field notes on participants' comments regarding why they provided their scoring were recorded with the survey answers. The overall opinion questions asked participants

if they would purchase the item if it were in vending machines on campus, as well as which aspect made them want or not want to purchase the product – taste, price, promotion, or other.

Data analysis for phase 2 was conducted in a similar manner to phase 1. Scoring was provided for the product liking and preference as well as pricing and promotion liking, preference, and influence questions by totaling the scores from each of the questions in the respective categories for each option. The highest scoring product, price and promotion were considered the most desirable among participants.

Finally, statistical differences in demographics between phase 1 and phase 2 groups were tested. First, normality was tested using a Shapiro-Wilk test. If the Shapiro-Wilk's test indicated these variables were normally distributed (p>0.05), independent samples t-tests were used to determine differences between phase 1 and 2 samples, otherwise medians and interquartile ranges were used to describe the variables and Mann-Whitney U tests were used to determine differences between the samples. A chi-square test was used to determine differences in categorical variables between phase 1 and 2 samples, unless there was an expected cell count of less than 5, where Fisher's Exact Test was used. Before analysis, the categorical variables were pre-processed into dichotomous variables to account for small cell sizes in the minority categories. The resulting categorical variables compared included race (combined groups to be "white" and "non-white") and academic class (combined groups to be "lowerclassmen" and "upperclassmen").

Results

Demographic characteristics for participants completing interviews for Phase 1, Phase 2, and overall can be found in Table B.2. The continuous variables of age and BMI were not normally distributed. A majority of participants were white (n=48; 80%) and had normal BMI weight status (n=45; 75%), with 50% being lowerclassmen. The overall sample median age was 20 [IQR=19, 20]. The most common academic majors were in either the college of arts and sciences (n=21; 35%) or engineering (n=12; 20%) and. There were no significant differences in demographics between participants in phase 1 and phase 2.

Phase 1: Exploratory Phase

The quantitative summary scores for product and promotion can be found in Table B.3 and the quantitative data for pricing can be found in Table B.4. The product flavors with the highest total scores for Phase 1 were "peppered" and "spicy," each with 130 points. For pricing, participants mentioned a significantly higher price for how much they thought the product actually costs (M=$1.83) than how much the product should cost (M=$1.46), with a mean difference of $0.37 ($p$=.005). The identified price that would make them more likely to purchase the product was the lowest of the three identified prices (M = $1.03), which was also significantly lower than how much they thought the product actually costs, with a mean difference of $0.80 ($p$<0.001). Boxplot analysis of influential prices led to the three defined pricing levels of $0.75 (lower price), $1.00 (standard price), and $1.25 (higher price). The three highest scoring promotions were 'healthy item categories' (177 points), 'product nutrient information' (166 points) and 'additional product information' (223 points). The only two promotions where a majority of participants indicated the promotion would make them want to purchase the product were 'product nutrient information' (n=16, 53.3%) and 'additional product information' (n=22, 73.3%).

Product

The qualitative comments for the product flavors fit within one of two major themes: *taste* and *texture*. Nearly all participants indicated their like or dislike of the taste of the products dictated their opinion of those products. A majority of participants also mentioned improving different

aspects of the taste of all of the product flavors – such as less fruit flavor, stronger spice flavor, or less spicy flavor – as a suggestion that would make them like each product more. Regarding texture, participants commonly mentioned they liked the crunchiness of the product but did not like the dry or chalky mouthfeel, with some flavor textures being disliked more than others.

Price

The qualitative pricing data provided four major themes: *higher priced healthier or high-quality items*, *affordability for college students*, *comparison to other items* and *convenience of payment method.* A majority of participants mentioned the product probably was or should be more expensive because they perceived it to be healthier. The product being healthier or of high quality was also commonly mentioned by participants as reasons for why they would be willing to pay more for the product. In addition, many participants gave justification for identifying a lower price by stating they, along with other college students, would be more likely to purchase it at a lower price because it would make it more affordable, with many describing themselves as a "broke college student." Another common justification for pricing levels included comparison of the product to similar items already in vending machines. Another interesting finding was some participants identifying $1.00 as the price that would make them more likely to purchase the product, solely based on the fact that it was a convenient payment amount. Based on analysis of this qualitative data, a question regarding payment method was added to phase 2, asking participants to identify their common method of payment when purchasing items from the vending machines on campus.

Promotion

The qualitative promotional information provided three major themes: *simple and clear product information, health-related benefits,* and *visual appeal.* The most commonly mentioned reason for rating, influence, and ranking scores was the availability of adequate, clear information. The promotional strategies rated poorly were described as having too much or confusing information that was not helpful. Many other positive comments were related to promotions identifying the product as being healthier, with many participants suggesting this would influence them to purchase the product. However, if the health information provided had too much text or the participants perceived a lack of evidence to support the health-related claims, this information was considered to be a negative promotion aspect. In fact, information being clear and simple was commonly preferred by participants, with one of the major suggestions to improvement being to further simplify some of the information on the provided strategies. Another commonly suggested improvement related to the type of information provided, with suggestions that the promotions also appeal to their sense of taste, since this is a major contributing factor to their product choice.

Participants also commonly mentioned liking or disliking the visual appeal of the promotional strategies as an explanation for their rating, ranking, or influence scores. The positive comments for the highly rated promotions were related to simple colors and product logos used. Contrarily, many participants identified the major negative for the lower rated promotions were the graphics, layout, and font not looking professional, with participants frequently recommending the removal of "cheesy" clip art or stock photo graphics and changing the comic sans font. Overall, students indicated those strategies rated the highest were those that had visual appeal and simple information that would quickly grab their attention.

Phase 1 Revisions

Based on the quantitative and qualitative information for the promotions, a group of student researchers decided to only use the 'product nutrient information' and 'additional product information' promotions, without also including the 'healthy item categories' promotion even

though it was the third highest scoring option. This decision was reached due to realization that the 'healthy item categories' promotion was not specifically related to the product, but rather the overall healthfulness of all vending machine items, meaning it would not necessarily influence purchase of the targeted product. This idea was confirmed by the 'healthy item categories' promotion receiving the lowest influence score of the three strategies. In addition, participants had many suggestions for improving the information or unclear messages and visual appeal or colors of this promotion, but since it was already developed, changes could not have been made as easily as some of the others.

When deciding how to revise the 'product nutrient information' and 'additional product information' promotions, the student researchers looked at the question asking participants which technique within each strategy they liked best and any suggested improvements they had for each promotion. For the 'product nutrient information', the two most popular techniques, which identified the product as "high fiber, low fat, and full of protein" and as having 100 calories, were combined. The most commonly suggested revisions of changing the font from comic sans to one that better matched the logo and changing the colors to make it more visually appealing were also made. The major suggested improvement to the 'additional product information' promotion was to simplify the information or techniques used. The most popular promotions within this strategy had photos of the product bag and flavor descriptions, provided a general health message of "a beautiful balance of health and flavor," and provided visuals of talking beans with general health benefit information. The panel of student researchers decided not to use the promotion with photos of the product bag and flavor descriptions because the promotion would be next to the product package in the vending machines. The remaining two promotions were each chosen as the second and third promotions to be tested in phase 2. The revised promotions were relabeled as "specific nutrients" (nutrient highlights and 100 calories), "talking beans" (product nutrient information and talking beans) and "health and flavor" ("beautiful balance of health and flavor" message).

Phase 2: Confirmatory Phase

Summary quantitative scores for product, price, and promotion options for phase 2 can be found in Table B.3. The "peppered" product scored higher than the "spicy" product with a total of 90 points and an average rating score of 2.5. However, the ranking scores were almost even, with only one more participant indicating they preferred the "peppered" over "spicy" product. The lowest price point of $0.75 price had the highest total score with 80 points. However, six participants preferred the $1.00 level over the $0.75 level because they did not have or want change. The average price indicated by participants for how much they thought the product actually cost was $1.54, which was higher than any of the three pricing options. Additionally, participants commonly mentioned all of the listed prices were less than what they thought the product would cost and less than what they were willing to pay. Regarding payment methods, a majority of participants use cash to purchase items from the vending machines, (n=17; 57%) with a moderate number of participants using their student identification card (n=10; 33%), which allows them to purchase items with funds from their university dining account, and a few participants using their credit or debit card (n=3; 10%).

The "specific nutrients" promotion was the highest scoring promotion with 148 total points. Though a majority of participants indicated all of the promotions would make them more likely to purchase the product, the "specific nutrients" promotion had the highest proportion of participants indicating it would make them more likely to purchase the product (n=23; 76.7%). "Specific nutrients" and "health and flavor" were also similar in their rankings with 14 (47%) and 13 (43%) participants choosing those promotions as the ones that would have the highest influence on their purchasing the product. In addition, "specific nutrients" was the only option where a majority of

participants (*n*=16, 53%) provided positive qualitative feedback, with many participants indicating the short, simple, and easy to understand nutrition information provided was what influenced their scoring. Other qualitative feedback comments were similar to phase 1 in that participants rated those considered to be visually appealing higher, specifically mentioning their preference for large, colorful graphics that caught their attention. In addition, strategies that either provided too much or not enough descriptive information about the product were scored less favorably.

Overall and Vending Usage

The overall opinion of the product was positive, with a majority (*n*=42; 70%) of participants from phase 1 and 2 indicating they would purchase the product if it were in the vending machines on campus. Approximately 50% (*n*=21) of those that would purchase the item said it was due to their liking the taste, with 28% (*n*=12) indicating their likely purchase was due to their perception of it being a healthful product. Similarly, the few participants that indicated they might purchase the item (*n*=8; 13%) or would not purchase the item (*n*=10; 17%) mentioned not liking the taste as the most common reason. In phase 2, the item being sold at an acceptable price (*n*=14; 47%) and liking promotions provided (*n*=22; 73%) were also common reasons for wanting to purchase the product. Regardless of whether they indicated they would purchase the product, 36% (*n*=11) of participants in phase 1 mentioned a lower price would make them more likely to purchase the product.

A majority of participants interviewed in both phases and overall used vending machines less than 1 time per month (*n*=36; 60%). Figure B.1 provides the results of the questions regarding the most common reasons for purchasing items from vending machines and choosing which item to purchase from vending machines. The most common reasons for purchasing items from vending machines were hunger (*n*=23; 38%), lack of time or being in a hurry (*n*=18; 30%), and the convenience or easy accessibility of vending machines (*n*=18; 30%). Participants' most common reasons for choosing which item to purchase from vending machines included price (*n*=12; 20%), health or nutrition (*n*=12; 20%), taste (*n*=9; 15%), and cravings (*n*=9; 15%).

Discussion

This project utilized a comprehensive, multi-phase marketing research strategy to evaluate the opinions and acceptability of different marketing techniques. Using both quantitative and qualitative data collection methods with this study served to strengthen the overall project by providing different levels of analysis to explain and interpret data collected with each phase.[160] The unique use of quantitative scoring to objectively determine the most liked, preferred, and influential strategies was confirmed using qualitative insights that provided more information and context as to why each technique was liked, preferred, or influential. The unique concurrent multiple methods allowed us to provide a methodology for systematically evaluating, selecting, and revising initial strategies using direct input from the target population with phase 1, which were then confirmed using another group of participants in the target population in phase 2.

Product: Taste and Health

The taste and healthfulness of the product being the most commonly mentioned reasons for participants' liking or preference, potential influence, and likelihood of purchasing the product as well as overall reasons for snack choice from the vending machines is consistent with other research findings.[74, 92, 93, 99, 110, 116, 119] College students' attitudes of healthier snacks found in this study was also demonstrated in a study by Lillehoj, Nothwehr, Shipley, and Voss, where college students agreed eating healthier snacks was important to them and also stressed the importance of having healthier options available in vending machines.[99] Additionally, participants' ideas of

health in this study demonstrated with their critiques of the health-related promotions align with previous research indicating consumers perceive general product health claims portraying an overall healthful image more positively than specific disease reduction health claims for products.[171] Furthermore, while participants in this study stated they desired a product that was both healthful and tasty, many current interventions rarely take both taste and health into account.[79] This may be due to other contradictory findings that state vending machine users often value taste or cravings over health when purchasing items, because they usually expect and desire to get an unhealthy item from this venue.[92] What consumers find important in making purchasing decisions, in this case being the taste and health of the product, should both be taken into consideration when planning other aspects of marketing to influence consumer purchasing or behavior.[48, 57, 159]

Price: Lower Amount and Convenience

The price or cost of vending snack products being one of the most commonly mentioned reasons for snack choice from vending machines has also been shown in other research in this population.[74, 99, 119] Furthermore, many participants in this study suggested a lower price would make them more likely to purchase the product, a finding also supported by previous qualitative research with college students.[92] This idea is also consistent with the law of demand, which states, all other things held constant, if the price of an item is decreased, the quantity demanded of that item will increase, and vice versa.[130] While this evidence may suggest a focus on price reduction for new items to increase potential success, Glanz, Bader, and Iyer have stated that interventions which aim to reduce the price of a product may be effective at increasing purchases initially, but are usually not sustainable long-term.[117]

The health of the product is something that extended into the desired price as well. The participants in this study shared the common expectation of healthier items being more expensive, with their willingness to pay more for the item depending on their ideas about the value of health.[96, 99] Another study by Carrad et al. also indicated 47 percent of college students surveyed were willing to pay the same amount for healthy items as compared to unhealthy items while 32 percent were willing to pay more for healthy items.[94] Lillehoj et al. had similar findings, where participants' were split in their willingness to pay more for healthier items.[99] Ultimately, these findings indicate the influence of health on price depends on personal factors and attitudes related to health, including the value individuals place on purchasing healthy products, which is something that should be evaluated with future research.

Another interesting finding of this study related to price was that participants were not only influenced by amount, but also by payment convenience. In both phases, participants often indicated they were willing to pay more for the product if the price was one that could be paid conveniently. In many cases, the participants mentioned they do not carry change and do not want change, meaning they would rather pay an even amount for an item or use their student ID or credit card to purchase items from vending machines, a finding also documented in another study in this population and setting.[92] While more research is needed to determine the influence of payment convenience on intended and actual purchasing behavior, this factor may be important to consider with future vending interventions.

Promotions: Appeal and Simple Information

The strategies that were most preferred were those perceived as providing adequate information while also being visually appealing. Arens defines this discovered idea as the art direction of an advertisement, which is the whole presentation of a promotion including the visual and verbal aspects, that communicate necessary information to potential consumers while also stimulating positive attitudes of the targeted product.[172] The ultimate goal of this type of design is

to increase purchasing decisions, which is a concept supported with the results of this study indicating those products with the most positive comments regarding visuals and information also being more likely to influence participants' potential purchase the product.[173] Particularly, the results of the qualitative reasoning from this study follow the "big, colorful, simple" strategy mentioned by Stahlberg and Malia, which includes promotions that make customers notice the product while communicating simple information, which would, in turn, make them stop and evaluate the importance of the message that is hopefully providing them with a relevant reason to buy the product.[173] The results of this study provide unique evidence that this "big, colorful, simple" strategy has the potential to positively influence purchases among college students when used in the context on vending machines, and therefore should be considered for incorporation in future interventions for further testing.

This study also provides results to strengthen the current inconclusive evidence regarding the which type of nutrition information is most influential in the college population and vending setting. Particularly, these study results support other findings indicating college students desire specific nutrient benefit and calorie information for a product at the point-of-purchase, often indicating it would influence their purchasing of a healthier item.[92, 139] However, research indicates that consumers' stated behavioral intent, including using nutrition information and labels when making food purchasing decisions, is often different than actual behavior.[150, 159, 173] The SCT offers the explanation of the potential effectiveness of health promotions relying heavily on the personal ideas, beliefs, and characteristics of the targeted consumers.[57, 58, 86] For example, taste and health were not only the most important reasons for product preference, but were also commonly mentioned when evaluating promotions. However, as demonstrated in this and other studies, the potential influence of the included health-related information relied on an individual's health beliefs and knowledge, including what information they value when making decisions about health and their ability to appropriately understand nutrition information, both of which influence their likelihood of utilizing the information.[100, 150] Therefore, future studies should build upon these findings to determine how and why particular nutrition or health information are influential to a population as well as test the actual behavior resulting from using this information rather than just measuring behavioral intent.

Overall and Vending Usage

The results of this study indicated vending machines seemed to be an appropriate place to introduce a healthier snack product. Similar to other studies, many participants utilized vending machines due to a lack of time or need for convenience or easy accessibility.[90, 92] However, this study also found participants most commonly utilized vending machines when they were hungry, which was only found in one other study by Caruso, Klein, and Kaye.[93] Hunger was also mentioned as an influential factor in snack choice, though it was not as common as some of the other factors and not as prevalent as what has been seen with other studies.[93, 119] Though the reasons of convenience and hunger are less relevant for point-of-purchase marketing strategies, where consumers will already be at the machines, incorporating these concepts into more wide-reaching campaigns may be helpful to attract consumers to the vending machines where they will then be exposed to the point-of-purchase promotional strategies.

However, one limitation is that this study population may not be entirely representative of typical vending users. Though the participants were screened to exclude those who never or rarely utilized vending machines, the predominant frequency in which participants purchased items from vending machines being less than once a month is different than previous studies where approximately 50% of college students purchased items from vending machines at least once a week.[27, 62, 93, 99] This difference in frequency of usage may be related to the testing taking place in

a neutral area in the library rather than near vending machines as seen in other studies.[92, 93] In addition, by testing the product away from the intended setting of vending machines, participants might have had a different reaction than they would in a vending setting, when more familiar options are present and available.[88, 172] Furthermore, actually being in the situation of purchasing vending items might evoke certain emotions that would likely influence purchasing behavior.

Finally, this study is not exempt from the common limitation with multiple methods study designs in that it only included a small sample size of 60 participants rather than a larger sample commonly used in other vending assessment surveys.[27, 88, 92, 93] However, a strength of this study is that we obtained a sample that was equal in terms of gender, since this demographic has been shown to predict food preferences, choices and reasons for choice, as well as preferred dining locations and admitted influence of point-of-purchase promotions in the college population.[163, 174] In addition, while the majority white sample (80%) reflects the proportion found in the sample university, evidence of significant differences in food choices and reasons for food choice between different races and ethnicities in the college population leads to a potential additional limitation of this study.[162, 163, 165] Particularly, individuals' food choices have been shown to be related to their perceived ideals, identities, and roles associated with different races and ethnicities, with this being most apparent during times of personal transition, which is commonly experienced among college students.[6, 162] Future studies should incorporate a diverse and even mix of individuals to get a true representation of the college population they hope to impact.

Conclusion

This study provides an example of a comprehensive descriptive marketing research methodology to gather consumer insights regarding marketing strategies from the unique and understudied population of college students and environment of campus vending machines to inform the development of future environmental interventions.[88, 175] The most important findings from this study include the qualitative findings suggesting reasoning for student vending machine users' liking, preference, and potential influence of different products, prices, or promotions.[88, 158, 175] These findings also provide insight into the specific factors student vending users find most important or influential when making purchasing decisions, including the taste and health of the product, low pricing, and visually appealing and informative promotions.[158, 159, 175] All of these influential factors should be taken into consideration when designing a vending intervention to improve the potential acceptability and purchase of a product for the success of an intervention. Furthermore, the comprehensive multiple-method and multi-phase methodology developed with this study could be employed in other specific vending settings as a way to inform a specific vending intervention prior to implementation to improve potential success. Once a marketing strategy is tested with this methodology and implemented, further observational research should be conducted at vending machines to evaluate and interpret actual behaviors of student vending users while also potentially gathering further qualitative data on the opinions and influence from those students at the point-of-sale.[88]

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CHAPTER II:
Description and Comparison of Contents, Traffic, and Consumer Demographics of Vending Machines on a College Campus

Abstract

College students have identified frequent unhealthy snacking from vending machines as an important influence on their dietary intake and weight status. Before developing interventions to improve vending on a college campus, formative research on current contents, traffic, and consumer characteristics is needed. The Nutritional Environmental Measures Survey for Vending (NEMS-V) methodology was used to measure the total proportion of "healthy" items in a purposive sample of 12 of the most popular vending machines on campus in a variety of locations (classrooms n = 5; residential n = 4; office n = 3). Traffic and consumer characteristics were collected at 8 of the 12 highest-trafficked vending machines over a 4-hour period on Monday, the busiest weekday. Traffic was recorded using purchase counts by half-hour. Intercept surveys were used to gather data on student customer demographics, vending machine usage, reasons for vending purchases, perceived hunger, and perceived health. Data was analyzed to provide descriptive statistics overall and by location type. Content assessment indicated 6.25% of all vending items were considered healthy (range 2.6 to 11.1% in individual machines). There were a total of 99 purchases at all machines, with the highest trafficked location type being residential (M = 15 purchases/machine) and times being between 1:00 and 2:00 p.m. (40% of total purchases). Of the 111 students who completed the intercept surveys, there were significant differences in age, academic class, and BMI level between location types. Almost half of students purchased items from vending machines on campus one time per month or less (45%). The most common reasons for purchasing items and choosing which item to purchase were hunger and cravings. Students reported they would change usual vending purchases if there were healthier options available or a change in price. This formative research can be utilized to inform development and measurement of specific healthy campus vending interventions targeting different location types.

Introduction

College students often experience rapid and sometimes large amounts of undesired weight gain,[11, 14, 15, 17] which can persist into adulthood[18] and contribute to the risk of chronic diseases such as type 2 diabetes and heart disease.[7] This weight gain seems to be related to negative changes in dietary behavior associated with the newfound independence experienced by the college-age group, between 18 and 24 years of age.[25] Specifically, college-aged students have higher fat intakes, lower fruit and vegetable intakes, and more unhealthy snacking patterns.[17, 32, 35, 38] Since approximately 70 percent of all individuals ages 18 to 25 were enrolled in college in 2018, interventions targeting college students are a viable option for introducing health interventions to impact the unique dietary habits and weight gain common with this age group.[19]

College students have specifically mentioned frequent snacking as an important influence on their dietary intake and weight status.[25] The number of snacks eaten per day and the number of times snacks are purchased away from home per week have both shown significant associations with unhealthy dietary behaviors that contribute to weight gain, including higher energy intake, lower fruit and vegetable intake, higher sugar-sweetened beverage intake, and more frequent fast food intake.[46, 47] This higher consumption of snack or convenience foods may be related to college students commonly identifying the lack of time to prepare and eat healthy foods as a barrier to healthy eating.[70-72, 74, 176] Students also identified highly available convenience foods, which students usually considered unhealthy, as an additional barrier to eating healthy.[71, 176] If the campus environment is not conducive to or supportive of students practicing healthy behavior, it may be less likely for students to make healthy choices.[58, 78]

Vending machines are a specific element of the college campus environment where college students frequently purchase snack food items.[27, 65, 90, 92, 93] However, frequent snacking from

vending machines on college campuses may lead to weight gain,[17, 110] possibly due to a majority of vending items being high in calories, sugar, fat, and saturated fat while also being low in other nutrients such as fiber.[17, 27, 102] College students are aware of the unhealthy nature of vending machines with vending machines being perceived as the least healthy campus food venue compared to dining halls and restaurants.[107] This poor perception is important because the Social Cognitive Theory (SCT) indicates behaviors, such as dietary choices may be influenced not only by environmental factors such as the high availability of less healthy items versus healthier items but also by personal factors such as the perception that vending machines only offer unhealthy items, or college students' need to fulfill personal taste preferences or cravings.[48, 58]

College students' frequent, unhealthy snacking from vending machines, and the potential effect of this pattern on weight gain, provide a potential area for intervention to improve dietary habits in this population. However, the current limited research available for a variety of different vending interventions in the college population have produced mixed results in terms of increasing purchase of healthy vending items.[105, 116, 137, 144, 147, 149] First, it is important to assess the current healthfulness of vending machine contents to determine how to improve the available options.[100] Assessing the usual sales traffic at different vending machine location types would also identify the best places to test an intervention. Additionally, there is little information available on characteristics and demographics of students purchasing items from vending machines, which would allow formation of strategies that match consumer needs.[159] It is also important to gather common consumer psychographics or profiles, including their interests and opinions regarding topics related to a certain behavior or product, to develop intervention strategies and messages that are relevant with this target market.[159] Another important aspect of vending machine description missing in the current literature is evaluation of differences between locations from which consumers purchase vending items. By determining characteristics of consumers and reasons for purchase at different location types around college campuses, vending interventions can be better targeted and adapted based on the clientele frequenting those location types.

The purpose of this project is to provide formative information for a vending intervention in the college population by gathering more detailed information to describe campus vending machines. Specifically, this project aims to describe vending machine contents, sales traffic, and consumer characteristics of users of a sample of vending machines on a college campus. In addition to overall description, this project aims to compare these vending characteristics between different location types.

Methods

This study took place at a large university in southeast United States during November of 2016. The study utilized a cross-sectional design to gather observational data on three primary outcomes: vending machine contents, sales traffic, and consumer characteristics.

Data Collection

Contents

A group of four trained student researchers collected observational data of vending machine contents over a two-week period using the reliable Nutritional Environmental Measures Survey for Vending (NEMS-V).[65] Following NEMS-V protocol, we measured a purposive sample of 12 snack vending machines at the university (16% of 74 available campus vending machines), identified as most popular by student researchers' opinions and informal observations.[65] Only snack, and not beverage, machines and items were included in this study. Of these machines, five were located in classroom buildings, four were located in residence halls, and three were located in office buildings.[93, 102] Data collection involved student researchers following the NEMS-V

protocols and criteria to record the total number of green or "healthy", yellow or "moderately healthy, and red or "not healthy" items in all of the assessed machines.[65] Per NEMS-V protocol, researchers also gathered descriptive data for each machine, including vending machine location within a building, working order, hours of operation, cleanliness, and advertising present.[65]

Sales Traffic and Consumer Characteristics

A team of 15 trained student researchers collected sales traffic and consumer characteristic data at a purposive sample of 8 of the 12 previously measured snack vending machines (11% of 74 available campus vending machines) on a Monday, perceived as the busiest weekday, during the four hours of 10 a.m. and 2 p.m., identified as the most popular time for vending purchases.[93] Five vending machines were located in classroom buildings, two were located in residence halls, and one was located in an office building.[93, 102] Sales traffic was measured by using an observational consumer tally sheet organized in eight, half-hour increments. Student researchers placed a tally mark for each observed snack purchase in the appropriate half-hour time slot. The observed purchases were recorded by number of items rather than individuals. This information provided descriptive information on total number of purchases, purchases by location type, and purchases by time period.

Consumer data were gathered using brief intercept surveys. The target population for the intercept surveys included students at the study university who utilized the vending machine.[88] However, all consumers who approached the vending machines during the data collection time period, regardless of whether or not they made a purchase during that time, were asked to participate as they were leaving the vending area, pending eligibility. Students were eligible to participate if they were a student at the university, at least 18 years of age, and if they indicated their frequency of vending usage, measured on a six-point scale,[106] was more than "never or rarely." *A priori* power analysis conducted indicated the appropriate sample size needed to detect differences between groups using a one-way analysis of variance (ANOVA) statistical test (medium standard effect size f = 0.3,[177, 178] α err prob = 0.05, power = 0.8, number of groups = 3) was 111 participants.[179] To ensure we met this number, we set a participant recruitment goal of at least 25 students per machine (200 total participants), based on previous research in this population.[116] An effort was made to assess equal proportions of males and females at each machine to provide an overall equal sample. Intercept survey data were collected from participants using online surveys accessible by electronic tablets. The survey took approximately five minutes to complete and participants received a five-dollar gift card, as an incentive, after completion.

The intercept survey gathered data on participants' demographics and consumer characteristics. Demographics included age, sex, race, and academic year. Self-reported height and weight were also collected to calculate body mass index (BMI), which were then categorized into ordinal levels.[180] Consumer characteristics included frequency and reasons for vending usage, perceived hunger and perceived healthy lifestyle. Participants were also asked to identify their usual reasons for purchasing items, choosing which item to purchase, and changing usual vending purchases using multiple response options derived from previous vending surveys in this population.[92, 93, 99] Perceived hunger and healthy lifestyle were measured based on previous research identifying these factors as strong predictors of vending usage and food choice among college students.[92, 93, 99, 119] Perceived hunger was measured on a previously developed nine-point scale.[181] Perceived health asked participants to rate their perceived current overall health using a five-point scale previously used in this age-group.[182]

Data Analysis

Data analysis was conducted to provide descriptive statistics by machine, overall and by location type, as well as comparisons between vending location types. Before data analysis, normality of all continuous data was checked using a Shapiro-Wilk's test.[183] Continuous variables included contents analyzed as the proportion of total items categorized as healthy ("green" or "yellow"),[65] sales traffic analyzed as a count, and consumer characteristics of age, BMI, and average perceived hunger and health. If normally distributed, a one-way ANOVA was conducted to compare the continuous variables between location types, otherwise, the non-parametric Kruskal-Wallis tests were used for statistical comparisons and medians and interquartile ranges were used for descriptives. Before statistical comparisons, the categorical demographic variables of race and BMI level and consumer characteristic variables of frequency of vending usage and perceived hunger were pre-processed into simplified categories to account for expected minority responses for some of the options. In addition, since reasons why participants purchased, chose, or changed usual vending purchases were not mutually exclusive, the answer choices were coded as dichotomous "yes" or "no" options. All categorical variables were then compared between location types using Pearson's chi-square tests, unless there were expected small cell counts, where Fisher's exact tests were used.

Results

Contents

A total of 416 vending items were observed from the twelve vending machines, with an average of 34.67 items available per machine. The overall average percentage of healthy items was 6.25%, with the individual machine percentages ranging from 2.6 to 11.1% (Figure C.1). The average percentage of healthy items was not significantly different by location type, 6.4% in classroom, 5.4% percent in residential, and 7.5% in office buildings ($F = .428$; $p = 0.665$).

In addition to vending contents, other general vending machine characteristics were assessed using the NEMS-V methodology (Table C.1). Many of the vending machines were located in the front lobby of a building (n=5; 42%). The hours of operation were related to the building operating hours or outdoor location, with half of the locations being open 24 hours a day (4 residential, 2 office). All vending machines were in working order and all but one location, an outside office building machine, were considered to have acceptable cleanliness. Assessment of the advertising present found signs on four vending machines (33%) – one classroom, two residential and one office – all of which were for "red" food items.

Sales Traffic

A total of 99 purchases were made from the eight machines during the period of observation, for an average of 12.4 items purchased at each machine. Of those purchases, 67 were from classroom machines (mean=13.4), 30 from residential machines (mean=15), and 2 from the office machine. The time-period with the highest traffic overall and at each location was between 1:00 p.m. and 2:00 p.m. (40% of total purchases) (Figure C.2). There were no significant differences in the average number of items purchased by location type ($F=1.514$, p=.306).

Consumer Characteristics

Of approximately 180 individuals who approached the eight observed machines during the data collection time period, 144 students completed the intercept survey. However, 33 students were deemed ineligible based on their indication they "never or rarely" use vending machines. Therefore, the total sample included 111 eligible participants, which provided sufficient power. Of

the total participants, 79 visited classroom (M=16), 25 visited residential (M=13), and 7 visited office machines.

The majority of participants were white (87%) and female (58%) (Table C.2). Tests of normality revealed that age, BMI, hunger, and health were not normally distributed. The median age of participants was 21 years and median BMI was 24.2 kg/m^2, with a majority of participants within the normal BMI range (54%). Participants' median hunger rating was 4 on a nine-point scale and their median perception of health was 4 on a five-point scale, with a majority of students perceiving their health to be "good" (51%). Most participants (41%) identified using vending machines at a "moderate" frequency, or once to twice a month. Data were missing for two participants for the academic year variable, one participant for the academic college of major variable, one participant for the perceived health variable, and one participant for weight and the subsequent calculations of BMI and BMI categories. These individuals were excluded from statistical analysis with those variables using a listwise method of deletion.

Statistical comparisons revealed the location types were significantly different on the measures of age (p<.001) and academic year (p<.001) as well as BMI level (p=.043) (Table C.2). Specifically, the residential locations had the highest proportion of freshman (64%) and the lowest median age (18; IQR=[18, 20]). Conversely, classrooms had the highest proportion of seniors (39%), with 91% of participants identified as seniors being from the classroom setting, and the highest median age (21; IQR=[20, 23]). Classrooms also had the highest median continuous BMI (25.1, IQR=[22.4, 28.5]) and the only location where a majority of participants were categorized in the overweight/obese BMI level (51%).

The most commonly identified reasons for purchasing items from vending machines on campus were hunger, lack of time or being in a hurry, convenience, and cravings (Table C.3, Figure C.3). Cravings were also the most common reason for deciding what item to purchase from vending machines, followed by hunger, taste, and price. A majority of students indicated they would change their usual vending purchases if there were a change in item price, healthier options available, or new or unique options introduced. There were no significant differences in the reasons chosen between the three location types (Table C.3).

Discussion

The results of this study provided a description of vending and consumer characteristics to inform the framing of future interventions. Though this study describes the specific characteristics of one particular campus, the methodology and resulting characteristics can be used for comparison to the limited previous research in this population and setting for consistency and relevancy. For example, while the low proportion of healthy items in the vending machines in this study is concerning, other studies utilizing the same NEMS-V methodology in university settings found similarly low proportions where between 2.7 and 8.8% of total vending items were considered healthy.[97, 99, 101] However, approximately 30% of college students surveyed reported using vending machines at least once per week in this study, which is lower than previous findings where approximately 50% of college students reported used vending machines weekly.[27, 62, 93, 99] This discrepancy might be due to the previously mentioned studies having much larger sample sizes and a longer time period of study.[27, 62, 93, 99] More information is needed to determine the reasons and implications of frequency of vending machine usage to appropriately incorporate it into an intervention.

Consumer Characteristics: Reasons for Vending Usage

Similar to other study findings, hunger and convenience were the most commonly mentioned reasons for vending machine purchases.[92, 93, 184] Additionally, hunger was commonly

mentioned as an influence for snack item choice, a finding also supported by previous research in this population.[99, 114, 119]. Though the average participant rating for current level of hunger was in the middle of the nine-point scale, research shows even at low levels, hunger was significantly negatively associated with self-control and healthy choices.[185] Finding lack of time or being in a hurry combined with the convenience or easy accessibility of vending machines were influential factors on purchases is also similar to previous vending studies with college students.[92, 93, 184] These and other findings indicate time and convenience are essential to note for future interventions targeting vending in this population, as they have also been commonly identified as barriers to healthy eating behaviors among college students.[70, 71, 176, 186] One potential way an intervention could take this into consideration is ensuring vending machines are stocked with healthy items that are easy to consume on-the-go. Ensuring vending machines with healthy items are easily accessible to students at convenient hours and locations, which can be measured using NEMS-V protocol,[65] would also be a useful aspect of an intervention.

Participants' indication that they would change their usual vending purchases if healthier items were made available may provide evidence for the potential success of interventions focused on improving healthy options in vending machines.[50, 92, 184] However, these study findings also support research indicating college students value cravings or taste over health when purchasing items from vending machines, with immediate satisfaction of a less healthy item outweighing their perceived importance of potential health benefits of a healthier option.[92, 106] Furthermore, while a majority of students perceived their current health was good (51%), 31% had a self-rated health of poor/fair, which has been associated with unhealthy dietary intake patterns, including inadequate fruit and vegetable intake and excess fat intake, and overweight or obese weight statuses in the older adolescence or young adult population.[182, 187, 188] Though these findings suggest health may be an important focus for this group, the fact that health was not the most important influence of purchase or choice from vending machines indicates future interventions should ensure any healthy products introduced with an intervention in this setting also meet and promote the taste and cravings needs of this population to increase potential purchase and choice.

Differences by Location Type

Some of the most interesting findings of this study came from comparing the results by different location types. Particularly, the residential locations had a significantly higher proportion of freshmen students using the vending machines, likely due to a higher proportion of residents being freshman. This concentration of freshman provides a unique opportunity for intervention since studies indicate the largest amount of weight gain among college students was during the freshman year.[9, 17, 18] In addition, while the contents were not significantly different between the locations, residential halls had the lowest average proportion of healthy items available of all of the locations. Residential halls were also the highest trafficked and the most easily accessible, with all locations being open 24 hours a day and usually located in the front lobby. Similar to another study by Klapheke, hunger was reported as a reason for purchasing items from vending machines less often among participants in residence halls compared to other locations,[92] despite the residential group in this study having a higher median perceived hunger rating than the other locations. The price of items was also listed as a reason for product choice more often among participants in residence halls compared to the other locations. The overall noted differences in the residence hall locations compared to the other locations could be used to inform a vending intervention strategy targeting residence hall vending locations with a focus on reaching the freshman population at higher risk for weight gain.

Vending machines in the classroom setting also provide a unique intervention opportunity since this location had a significantly higher prevalence of individuals in the overweight / obese

BMI level. These individuals also being significantly older than the other locations, with significantly more upperclassmen, allows for a potential unique intervention strategy focused on individuals in this age group, who may not be reached as easily as the captive audience at residence halls. In addition, hunger being mentioned more often by participants in the classroom setting, where vending machines may be the only source of food nearby and easily accessible,[97] also provides some level of captive attention that lends to a unique opportunity to provide and promote healthy options in these settings that can offer positive fulfillment.

Limitations and Future Research

While this study presents unique and useful information to frame vending interventions in this specific population to inform a specific intervention, there is the opportunity for other studies to utilize this methodology on a larger scale and scope with future studies. We chose the small sample of vending machines and short observation time period based on methodology from a similar study in this population.[93] In addition, since this study served to provide formative research for a small pilot study, our purposive sample of vending machines only included a small percentage of the total campus vending machines available. However, future studies wanting to increase generalizability of results should observe a larger sample of vending machines over a longer period of time. Furthermore, while the locations types chosen were based on previous vending research in this population,[93] the unequal sample size of both the number of machines in each location type and number of students measured at each machine and location type is another limitation that might influence comparability within our study. Though averages and proportions were used in comparisons between location types to account for differences in these sample sizes, the much larger sample size of from the classroom locations and much smaller sample size from the office location indicates comparisons between the groups should be interpreted with caution. In addition, while the small sample size of purchases observed and participants surveyed met the desired power analysis level, these sample sizes were smaller than other similar studies in this population.[92, 93] An effort was also made to choose the most popular vending locations regardless of type to get the most representative sample of vending users, but a more evenly dispersed sample may have provided a better means for comparison. Finally, though it was not in the scope of this study, the increasing availability of on-campus campus dining options, including campus convenience stores, may have also influenced the use of vending machines. However, recent changes in these campus dining options are not well-documented, suggesting the need for further research to understand the extent and impact of these changes.

One strength of this strategy is that it allowed a sample of real-time data to be captured, rather than the less reliable self-reported purchasing used with other studies,[116] while also allowing direct access to the consumer audience at the point-of-purchase. Using observational data collection methods is a strategy that has also been employed in similar vending machine descriptive studies in this population.[92, 93] However, while the observation time period was chosen based on input from students and vending representatives, it is limited in that it did not gather data from individuals who may purchase items at different times. Particularly, student researchers suggested residential hall vending usage may be higher late at night, due to convenience and limited availability of other dining options.[97] It is also unclear whether there would be any differences between students using vending machines at those different times and those students that used vending machines during the time of our observation. In addition, since the goal of this study was to measure basic sales traffic at different locations and times, we only gathered number of purchases. However, future studies could expand on this methodology to also record the types of purchases made at each vending machine for a more detailed sales description and comparison.[92, 93] An example of combining this methodology with more detailed observation data,

would be to include analysis of potential associations between reasons for visiting and/or choosing items from vending machines and actual items purchased.

The emphasis on personal choice also suggests further research should aim to gather information not only on the objective measures of the healthfulness of vending contents but also college students' perceived healthfulness of these venues. The actual and perceived unhealthy nature of college campus vending machines are important because they can influence individual dietary behaviors.[58, 78, 100] In addition, more information is needed to fill the gap between perceived health and influence of health when making vending purchases by assessing and comparing students' importance of eating healthy and their dietary choices.

Conclusion

The methods for assessing the college campus vending environment as well as the data on content, sales traffic, and consumer information, overall and in regard to location type, described with this study can be used to better frame specific healthy vending intervention strategies in the college campus setting and target population of college students. Measuring the current healthfulness of the vending machines provides rationale for implementing a healthy vending intervention as well as a measure for improvement before and after the intervention. By observing vending machine traffic, we were also able to identify a sample of popular locations and times of use to optimize testing of future interventions. The consumer information may also help frame interventions in a way that would better meet the consumer wants and needs in terms of what influences their purchases and choices from vending machines. Additional analysis in this study comparing the characteristics of vending machines and consumers in different locations promotes tailoring of interventions by location type. Future research should elaborate on the data from this study to assess and compare individual students' purchases as well as reasons for the time and location of purchase to further inform intervention strategies. The ultimate goal is that this information will serve to better inform vending intervention strategies that meet the needs and wants of student consumers frequenting vending machines to successfully promote improved dietary intake in this population.

CHAPTER III:
Evaluating the Awareness, Attitudes, and Purchase of a Vending Intervention Product Among College Students With and Without a Promotional Strategy

Abstract

Objective: To determine differences in college students' awareness, attitudes, and purchase of a healthy snack product introduced in campus vending machines with and without a point-of-purchase nutrition promotion. ***Methods:*** Two treatments – product only (P1) and product plus promotion (P2) – were randomly assigned to 8 campus vending machines for a 2-week period, with treatment crossover between weeks. The intervention product was a dried bean snack product and the promotion included nutrition information and claims. Data were collected using intercept interviews with college students purchasing vending items during a four-hour period each day. The primary outcomes statistically compared between treatments were students' awareness, attitudes, and purchase of the intervention product. Open-ended questions were also used to assess participants' response explanations regarding the primary outcomes. ***Results:*** The only three intervention products sold were in the P1 treatment. Thirteen interviews were conducted, with 9 in P1 and 4 in P2 treatments. Approximately 33% (*n*=3) of P1 and 25% (*n*=1) of P2 participants saw the product, while 50% (*n*=2) of P2 participants saw the promotion. Approximately half of the participants overall (*n*=6) and in the P1 treatment (*n*=4) had positive attitudes regarding the product while 25% (*n*=1) and 75% (*n*=3) of participants in the P2 treatment had positive attitudes of the product and promotion, respectively. There were no significant differences in awareness, attitudes, or purchases of the product between the two treatments. ***Conclusion:*** The results for the differing impacts of an intervention with and without a point-of-purchase promotion are inconclusive due to small sample sizes and fidelity issues. The key shopper insights from this study, as well as some of the unique measurement methods, can be used to inform future research in this setting and population.

Introduction

Young adults often experience weight gain when entering college,[11] likely related to unhealthy changes in dietary habits common with this population.[11, 25, 27] Specifically, an increase in frequent, unhealthy snacking behaviors has been associated with weight gain among college students.[25] The social cognitive theory (SCT) indicates an individuals' behavior is influenced by interactions with their environment as well as other personal factors.[48] The college campus environment has been shown to particularly influence dietary snacking choices and habits of college students,[62] where over half of college students purchase snack items from vending machines at least once a week.[27, 93] However, a majority of items in college campus vending machines are high in calories, sugar, fat, and saturated fat and low in fiber.[27, 102] These characteristics indicate potential for improvement of the healthfulness of campus vending machines, which has the potential to impact dietary choices of targeted individuals in this setting.[79]

One way in which personal and environmental factors interact to influence behavior is through students' attitudes and perceptions of the healthfulness of the environment.[48] According to the Theory of Planned Behavior (TPB), these perceptions influence an individual's perceived ease of making healthy choices and thus their likelihood of actually practicing healthy behaviors.[49, 59] That being said, a majority of college students report not being satisfied with the limited amount of healthy vending snack options currently available at their university, expressing interest in increased availability of healthy options, which they say would help them consume more healthful snacks and would increase their use of vending machines.[27, 90, 92, 99, 113] College students have also indicated their desire for labeling of healthy foods or providing health information on or near vending machines, often stating it would influence their decisions towards purchasing healthier items.[90, 92, 113] Providing nutrition information to consumers at the point-of-purchase has been commonly identified as one of the main facilitators to encouraging healthy eating through

environmental change by allowing consumers to easily judge if a product is considered healthful.[83, 84, 111, 135] However, the limited amount of vending research in the college population, all of which have different combinations of intervention strategies, indicate mixed results in terms of the effect on purchases of healthy items after increasing availability of healthy options or introducing point-of-purchase promotions.[105, 131, 134, 137, 149, 189]

Another limitation of current research is personal factors that may predict a promotion's influence are not usually measured simultaneously, including an individuals' awareness and attitudes of a product and promotion.[135, 142, 190] First, since awareness of a product is a key precursor for actual purchase, measuring this aspect may explain why a purchase may or may not have occurred.[136, 191, 192] Studies conducted in other populations and/or settings have found point-of-purchase promotions with general nutrition information increased awareness of healthy options, which was then associated with their changes in intended purchases.[136, 192] Consumers having positive attitudes or opinions regarding a product or promotional message is also an essential personal precursor to behavioral change that is important to measure and attempt to influence with interventions.[172, 190] Previous studies have indicated including promotions with nutrition information or claims have been associated with significantly more positive attitudes towards a product, more positive attitudes towards nutrition, and greater purchase intentions in the general adult population.[143] However, these studies have largely been completed in settings other than vending machine venues, which have distinctive challenges associated with providing nutrition information,[137] and populations other than the college-aged population, which often have unique attitudes and opinions regarding dietary behaviors that differ from other age groups.[6] Additionally, since the type of nutrition information provided with point-of-purchase promotions has shown to produce different influences,[142, 143, 193] it is important to conduct preliminary tests with specific promotions used for this target population and setting before implementation. Furthermore, studies indicate the use and influence of promotions that provide nutrition information is associated with interest in healthy eating, but this measure is not commonly included as part of an overall assessment.[135, 142] Finally, there is limited measurement and inconclusive evidence as to the specific influence of point-of-purchase promotions beyond just increasing the availability of healthy products, especially as it relates to smaller-scale interventions usually required before full-scale implementation.[95, 117, 134, 189]

One way to assess the personal factors related to the environment that influence behavior is by using marketing research.[88] Marketing research aims to go beyond just describing consumer purchases to better understand consumers' complex personal motivations for their purchasing behaviors.[89] This idea particularly relates to the concept of shopper marketing, which gathers insights related to individuals' mindsets while shopping to determine where, how, and why they shop.[190] Specifically, measuring shoppers' awareness, attitudes, and purchase provide insights to inform the development of shopper marketing strategies to 'stop, hold, and close' a shopper to purchase a specific targeted item.[190]

The purpose of this project was to assess and describe shopper marketing insights at the point-of-purchase to assess a preliminary, small-scale vending intervention strategy on a college campus introducing a specific healthful snack product and nutrition-related point-of-purchase promotion. The specific aim of this project was to determine differences in and reasons for college student vending users' awareness, attitudes, and purchase of the intervention product with and without point-of-purchase promotional signage available.

Methods

Study Design

This study took place over a two-week period in January 2017 at a large university in the southeastern United States. The study design was a pre-experimental design with alternative treatments, posttest-only, and non-equivalent groups.[160, 161] The two alternative treatments compared in this study were product only (P1) and product plus promotion (P2).

At the start of the spring 2017 semester, a healthful intervention snack product was introduced into a purposive sample of eight of the most popular vending machines on the study campus (11% of the 74 campus vending machines available). The vending machines were determined by a panel of five students from the target population and confirmed with formative research by this research group.[93, 102] Four of the vending machines were located in classrooms, two were located in residence halls, and two were located in office buildings.[93, 102] The product flavor and promotion message and design used as part of this intervention were determined from conducting two rounds of interviews with 60 students at the intervention university as part of formative research for this project.[184] The intervention product was a dried bean snack product in a flavor that was preferred by a majority of students in the target population sample, with 70% (n=42) indicating they would purchase it if it were in the vending machines on campus.[184] The intervention promotion was a 4 by 5 inch sticker placed on the machines with the product message of "high fiber, low fat, full of protein, and only 100 calories per package," which 77% (n=23) of students interviewed with formative research indicated would make them more likely to purchase the product (Figure D.1).[184]

Standard protocols for the intervention were developed and used throughout the intervention. Specifically, the product was required to be in stock in the vending machines, with the product placed as high in the machine as possible, contingent on slot size, near similar savory snack items such as nut mixes and/or crackers for relevant visibility and comparability. The promotion was to be placed on the upper right face of the machine, near eye level or method of payment, for optimal visibility. Per the vendor's request, the promotion was not placed on the glass of the machine, where it might obstruct the view of some products, or over any already existing promotions on the machine. The promotion was placed on each vending machine only during the data collection time periods for that machine, and removed when not being measured, to prevent potential contamination of this aspect of the intervention.

Data Collection

Data collection occurred during a two-week period with two of the eight sampled vending machines tested each day, for four days each week, so all eight machines were assessed each week.[93] Each day, one machine was randomly assigned to one of the two treatment options, with the other machine for that day receiving the other treatment. There was then crossover assignment of treatments, with each vending machine receiving the opposing treatment in week two. Data collection occurred during the four-hour period of 10 a.m. to 2 p.m. each day, identified by vending representatives and formative research as being the most popular time period for vending usage.[194] Each day, one of the two vending machines was assessed between 10 a.m. and 12 p.m. and the other assessed between 12 p.m. and 2 p.m., with the time period assignment based on preliminary observational data for sales traffic at each machine to maximize optimal traffic times.[194] The day and time assigned for each machine was consistent for week one and two.

Measures

The primary outcomes of data collection included participants' awareness, attitudes, and purchase of the intervention product as well as their awareness and attitudes of the intervention product and/or promotion. These outcomes were measured using intercept interviews with participants, with the purpose of gaining insight into consumer behavior and experiences. Secondary outcomes included participants' self-reported vending usage, demographic characteristics, and importance of eating healthy, gathered with the intercept interviews, as well as observational measures to ensure intervention fidelity and assess overall sales counts from vending machines.

Fidelity Testing

Fidelity tests were conducted on each study vending machine prior to the data collection time period. This testing included evaluation of vending machine contents (using Nutritional Environmental Measures Survey for Vending (NEMS-V)),[65] placement of the product, stocking of the product, and placement of the promotion in comparison with the standard intervention implementation protocol previously described. Observational field notes on any other noted differences between locations or notable factors that may have influenced purchases were recorded. The purpose of these data was to assess implementation consistency and determine the presence of any potential confounding factors that may have influenced the primary outcomes.[161]

Sales Reporting

Sales reporting was measured using recorded counts of products purchased by product type during the observation time period at each machine. This information was used to determine the proportion of purchases in each product category (intervention product, chips, crackers, candy, or pastries) in terms of total purchases as well as by treatment condition (P1 or P2) and participant group (those that purchased items and were interviewed vs. not interviewed).

Intercept Interviews

Potential participants were approached after they purchased an item and as they were walking away from the vending machine (purposive sampling), as to not influence their purchasing behavior. An individual was eligible to participate if they were a student at the study university, at least 18 years of age, and they were considered vending users, meaning their self-reported frequency of vending usage was more than "never or rarely" on a 6-point ordinal scale, adapted from previous vending usage studies in this population.[27, 62, 93, 99] In addition, students who participanted in any formative research related to this intervention product were not eligible to participate in these interviews to avoid any potenital testing or priming effect.

The intercept interviews were one-on-one survey organized around structured descriptive multiple-choice questions that then prompted open-ended, interpretive responses allowing further explanation if applicable (Table D.1). The questions used in the intercept interviews were designed by an expert panel of five researchers with experience in survey development with input from five members of the target population of college students. Before conducting the interviews, the questions were informally tested with a sample of student researchers to ensure clarity and understanding. The lead researcher, a registered dietitian/nutritionist (RDN), performed all of the intercept interviews to ensure consistency. The interviewer documented survey data by selecting the multiple choice response and then typing open-ended explanations as they were given into an online survey form using Qualtrics software.[166] Validity of responses recorded were verified with participants by the interviewer repeating responses back to participants after they were documented. The interviews took approximately 10 to 15 minutes to complete and participants received a $10 gift card as compensation for their participation.

The interview started by asking participants questions related to their vending usage. Participants were then asked open-ended questions allowing them to describe why they visited the machine that day, what they purchased, and why they chose to purchase that item. The participants were then asked either only the product questions or both the product and promotion questions, according to the current assigned treatment. To measure awareness of the product, the interviewer first asked all participants if they had seen the product in the vending machines that day. All participants were then asked to describe their attitude of the product. Only participants interviewed during the P2 treatment were asked the additional questions measuring awareness and attitude of the promotion as well as perceived influence of the promotion on their purchase of the intervention product. To assess prior exposure, participants were also asked if they had seen the product or promotion or purchased the product previously, with similar qualitative probing questions used to gather more information if they answered yes. Demographic questions regarding gender, race, height and weight to calculate body mass index (BMI), academic class, and academic major were gathered to determine personal characteristics of participants. Finally, participants were provided with the open-ended question asking them to describe how important eating healthy was to them. This measure was included based on evidence of this factor being associated with use and influence of point-of-purchase nutrition information similar to what is being used in this study.[135, 142]

Data Analysis

Since all quantitative measures were either dichotomous or multi-categorical, Pearson's chi-squared tests were used to determine statistical differences in the measures between groups, unless there were expected cell counts of less than 5 in at least one cell, where Fisher's exact tests were used. The exception to this includes the continuous demographic measures of age and BMI, where prior to statistical comparisons, normality were checked using a Shapiro-Wilk's test.[183] If the Shapiro-Wilk's test indicated these variables were normally distributed ($p>0.05$), independent samples t-tests were used to determine differences between groups, otherwise medians and interquartile ranges were used to describe the variables and Mann-Whitney U tests were used to determine differences between groups.

Fidelity Testing

For evaluation of vending contents, the proportion of total items with nutrition criteria classifying them as "healthy" (categorized as "green" or "yellow") were compared statistically between the eight machines. Each of the remaining intervention fidelity measures – stocking and placement of the product and placement of the promotion – were analyzed by data collection time point and interview conducted using a dichotomous "yes" or "no" measure for whether the vending machine during that time met each determined protocol. These measures were then compared statistically between the two treatment types by the proportion of data collection time points and proportion of interviews conducted where the vending machine met each protocol as well as all respective protocols.

Sales Reporting

Sales were analyzed for each product category to statistically compare the proportion of total items purchased in each category by treatment condition present during the data collection time point. The proportion of items purchased in each category was also statistically compared between those individuals who participated in the intercept interviews and those that did not to determine potential response bias.

Intercept Interviews

Descriptive statistics were calculated for all demographic variables overall and by treatment group. The demographics were compared statistically to determine if the P1 and P2 treatment groups were significantly different for any of the variables.

Evaluation of the primary outcomes was accomplished using both quantitative and qualitative analysis. Quantitative analysis provided frequencies for the proportion of participants in each treatment group that indicated they saw the intervention product or promotion (awareness) and proportion of participants in each treatment group that purchased the intervention product (purchase). The attitude toward the product and/or promotion was analyzed by assigning a code of "positive," "negative," "both positive and negative," or "neutral," based on the overall statement sentiment. The attitude measure was then analyzed in terms of participants who provided positive comments (categorized as "positive" or "both positive and negative"). The proportions for awareness, attitudes, and purchase were then statistically compared between treatment groups.

The open-ended interview data were analyzed using content analysis, which aims to classify open-ended text into categories or responses.[161] Specifically, data were analyzed using open coding, where each response was tagged with codes that summarize the concepts being portrayed.[161] Codes were subsequently transformed into frequency counts to be reported overall and by treatment type present. The codes were then analyzed for redundancy, with similar codes collapsed or combined to present a simplified set of codes. To ensure reliability, the lead researcher with experience in content analysis and one student researcher trained in content analysis by the lead researcher each coded the interview data separately. Intercoder agreement was conducted by the lead researcher, with the goal of at least 80% agreement in the codes included in the final analysis. For those codes where there were disagreements, the lead researcher and student researcher convened to discuss reasoning and rationale for their coding and a mutually agreed upon code was determined.

Ethical Statement

The Institutional Review Board at the study university approved all procedures prior to data collection. Before participation, all participants read and agreed to an approved informed consent. All data collected were de-identified before analysis.

Results

Fidelity Testing

A total of 273 items were evaluated from the eight vending machines observed during data collection (M=34.1 items per machine). There were no significant differences in proportion of healthy items between vending machines (p=.798; range of 2.6% to 11.1%) (data not shown). While the healthfulness of contents was not different between machines, observations indicated the types of products included in each machine and their placement in the machine was largely different between the different machines.

Intervention protocol compliance was low with 38% (n=6) of data collection time points and no interviews meeting all of the intervention protocols required (Table D.2). The intervention product was at least half stocked during a majority of the data collection time points (75%, n=12) and interviews (85%, n=11). However, the product was out of stock for one data collection timepoint (12.5%) and one interview (25%) during the P2 treatment. The intervention product was correctly placed in the 3rd row from the bottom (the highest row with the appropriate slot size) and near similar savory snack items for 38% (n=6) of data collection time points, with the majority of time points having the intervention product placed in the 2nd row from the bottom (50%, n=8), on

the right side of the row (56%, *n*=9), and near candy items (69%, *n*=11). The promotion was correctly placed at the top corner of the machine for half of the data collection time points and incorrectly placed at the bottom of the machine for the other half, due to differences in machine structure and already existing promotions. Furthermore, all of the P2 interviews had incorrect promotional placement at the bottom of the machine. Since the proportion of data collection timepoints and interviews that met the product placement and all protocols were the same for both treatments, the only statistical comparisons made were for product stocking levels, with no significant differences found between treatments for the data collection timepoints or interviews.

Some of the additional field notes for potential environmental confounding factors present during data collection included the inconsistencies between vending machines, the presence of other snack or food choices, and technology issues preventing sales. First, there were inconsistencies in the types of snack vending machines available, including the size and configuration of the product slots (which influenced the number, types, and placement of products in the machines) and the overall shape and configuration of the machines (which influenced the placement of the promotion). Not only were there inconsistencies in the types and placement of products in different machines, but there were also differences in prices between different product types, ranging from $0.50 for chips to $1.50 for large pastries. The price differentials between the two items commonly placed near the intervention product should also be noted with crackers and nuts being priced lower ($0.85) and the candy priced higher ($1.25) compared to the intervention product priced ($1.00). In addition, two locations had more competing snack options available, with two snack vending machines placed side-by-side, each stocked with different snacks and the intervention product only placed in one. Similarly, two locations had restaurants and one location had a campus convenience store in the same building as the vending machines. Finally, while all of the vending machines had technology that allowed the option for students to pay for items with their student ID card (6 locations) or a credit card (2 locations), these card readers were often out of order, which led many students who attempted to purchase items to walk away without purchasing anything.

Sales Reporting

A total of 36 purchases were observed during the observation time points (Table D.3). Specifically, 19 items and 17 items were purchased during the P1 and P2 treatments, respectively and 14 items and 22 items were purchased by interview participants and non-interview participants, respectively. After accounting for three individuals who purchased two items, there were a total of 33 individuals who purchased items overall, with 17 and 16 in the P1 and P2 treatments and 13 and 19 in the participant and non-participant groups, respectively.

Overall, the product category purchased most often was chips (*n*=17, 47%), with crackers and the intervention product being tied for the product categories purchased least often (*n*=3, 8%, each). The only significant difference was the proportion of chips purchased by treatment condition present (*p*=.018), with a significantly higher proportion chips purchased in the P2 treatment (*n*=12, 71%) compared to the P1 treatment (*n*=5, 26%). Three intervention products were sold (8% of purchases), all of which were during the P1 treatment.

Intercept Interviews

Of the 33 individuals who purchased items at the vending machines during the data collection time period, a total of 13 (39% response rate) agreed to participate in the interviews, with 9 interviewed during the P1 treatment (53% response rate) and 4 during the P2 treatment (25% response rate). Of the 20 individuals who did not participate, 18 declined, with most stating lack of time, while 2 were excluded due to their not being students at the university.

Summary demographics of participants overall and by treatment type can be found in table D.4. The Shapiro Wilk's test indicated age was not normally distributed (p<0.001) while BMI was normally distributed (p=.058). A majority of participants were male (62%, n=8), white (77%, n=10), with a median age of 21.0 years. A majority of participants were also in the normal BMI level (54%), but the average BMI was 27.2 kg/m^2, which is considered overweight. Continuous BMI was the only demographic variable that was significantly different between the P1 and P2 groups (p=.019), with the P2 group having a significantly higher average BMI.

The interviews took place at five of the eight vending machines, with nine interviews from three classroom buildings, one interview from one residential building, and three interviews from one office building. There were no statistically significant differences in the proportion of awareness, attitudes, or purchase of the product between the P1 and P2 groups (Table D.5). Table D.6. provides the code frequencies resulting from the transformed open-answer explanations for each concept, which are discussed in more detail below. The intercoder agreement for coding of the open-answer survey responses was acceptable, with 87% agreement.

Product Awareness, Attitudes, and Purchases

Four of the 13 participants (31%) saw the product, including three participants from the P1 treatment (33%) and one participant from the P2 treatment (25%). Some participants who did not see the product said they simply overlooked it (n=3, 23%), while other participants indicated their lack of awareness was due to the low placement of the product in the machine (n=2, 15%). Quotes that demonstrate this idea include:

> *"If I hadn't been told about it, I wouldn't have noticed it. It is a very non-descript bag. It either needs to be telling what it is or higher in the machine itself."* – Male, P1 Treatment

> *"If I would have seen the product and promotion before I purchased something, I definitely would have bought it. With it being a new product and it being down so low, it didn't really catch my attention."* – Male, P2 Treatment

All three participants (23%) who saw the product mentioned they did not know what the product was due to an unclear product description, with some participants thinking the product was a nut mix. Only one participant, who was in the P1 group, had seen the product before, with that participant indicating they didn't purchase the item currently or previously because they did not know what it was, and that he or she would have purchased the item had they been aware of what it was. Particular quotes that suggest these themes are:

> *"Yes. it looked different. I saw it but I didn't know what it was."* – Male, P1 Treatment

> *"I thought it was nuts, knowing it was beans makes me far more likely to purchase it. I like beans."* – Male, P1 Treatment

Approximately half of all participants overall (46%; n=6) and in the P1 treatment (56%; n=5), but only 25% in the P2 treatment (n=1), indicated positive attitudes of the product. These positive product comments were related to the product appearing new or different (n=3, 23%), appetizing (n=3, 23%), and healthy (n=2, 15%), with appealing packaging (n=2, 15%). Quotes that demonstrate these ideas include:

"It looked healthy. It looked like it would be better for you than chocolate or chips." – Male, P1 Treatment

"If I saw it, I would have bought it, it looks yummy." – Male, P1 Treatment

The most common negative product comments were related to the small packaging (*n*=2, 15%), with some indicating that influenced their perception of its price being more expensive related to other items (*n*=2, 15%), as demonstrated by this participant's quote:

"It looked like it was kind of expensive because it was down there with all of those other items, but it was kind of small." – Male, P1 Treatment

Despite two individuals indicating they wanted to try the product, with one in each treatment group, only one participant purchased the intervention product during the P1 treatment period of observation. This participant indicated they purchased the item because they were told about the product by a peer and thought it sounded new and interesting.

Promotion Awareness, Attitudes, and Influence

Two participants interviewed during the P2 treatment indicated they saw the promotion (50%). A majority of participants' in the P2 treatment indicated positive attitudes of the promotion (*n*=3, 75%). Participants' attitude of the promotion indicated they liked that it was promoting a new product, which increased its potential influence on their purchase. However, even with the promotion, there seemed to be some confusion regarding what the product was, as described by one interview participant:

"It would have influenced me. If I would have seen them, I would have seen that they were new and said, 'Oh, jelly beans!'." – Male, P2 Treatment

Related to the influence of the promotion, one of the participants who saw the promotion indicated it impacted their awareness but did not influence their purchase of the product:

"It made me notice it more, but I really didn't want it." – Male, P2 Treatment

The other participant who saw the promotion was interviewed when the product was out of stock, limiting the actual influence, though this participant indicated the promotion would have influenced his awareness and purchases had the product been in stock. Of the other two participants who did not see the promotion, one indicated if they had seen the promotion, it would have influenced them to purchase the product. None of the participants had seen the promotion previously. In addition, none of the participants interviewed during the experimental treatment purchased the product.

Vending Usage

A majority of participants used vending machines less than once per month (54%). The most common reasons participants indicated they visited the vending machines during the time of the interview were because they were hungry (*n*=6, 46%) and/or they skipped or needed to replace a meal (*n*=5, 38%). Other reasons for visiting the vending machine included convenience (*n*=2, 15%) and lack of time or being busy (*n*=1, 8%). Some participant quotes that demonstrate these themes include:

"I have longer classes today, so I don't have time to eat in between classes." – Female, P1 Treatment

"Because I haven't eaten, and I didn't feel like walking all the way over to the library." – Male, P2 Treatment

The most commonly mentioned reasons for participants' vending item choice at the time of the interview was their personal preferences or usual habits (*n*=5, 38%) and cravings (*n*=6, 46%), with participants commonly mentioning their cravings for something sweet or salty. Some participant quotes that demonstrate these findings include:

"I feel like chips are just a go to snack." – Male, P1 Treatment

"I was feeling something sweet." – Male, P2 Treatment

Other reasons for item choice included choosing items that were perceived as being filling (*n*=3, 23%), less unhealthy than other options (*n*=2, 15%), or inexpensive (*n*=2, 15%), as demonstrated by these quotes:

"They're cheap and presumably less unhealthy than some of the other stuff." – Male, P2 Treatment

"I know I like this and it is more filling than a candy bar." – Male, P1 Treatment

Importance of Healthy Eating

Approximately half of all participants indicated eating healthy was highly important to them (*n*=6, 46%), with the other half suggesting eating healthy was of moderate (*n*=4; 31%) or low importance (*n*=3; 23%) to them, with these proportions being similar between treatment groups (Table D.6). Among those participants who indicated eating healthy was of high importance to them, many gave the rationale that they believed it contributed to their health and well-being immediately (*n*=2) and in the long-term (*n*=4). Quotes that demonstrate this include:

"Recently I have been trying to eat healthy because going through college with long days and lots of studying, I need to eat healthy to make it through the day."– Female, P1 Treatment

"It helps me get through the day if I eat well. When I have classes my schedule is pretty tight and if I don't eat well then I feel blah and it drags me down." – Male, P2 Treatment

"Eating healthy is becoming very important to me… I want to make sure I live a long time and I think that's a big part of it."– Female, P1 Treatment

Among the majority of participants who indicated they try to eat healthy (*n*=8, 62%), many mentioned the presence of barriers sometimes prevented them from doing so. Some of the common identified barriers to healthy eating included busy schedules or lack of time (*n*=3, 23%), lack of available and/or convenient healthy options (*n*=2, 15%), personal preferences or habits (*n*=2,

15%), lack of confidence in abilities (*n*=2, 15%), and higher cost of healthy foods (*n*=1, 8%). Some of the quotes that demonstrate these barriers include:

> *"I have been trying to eat healthier lately. But since I don't have time in between classes, I settled for something less healthy."* – Male, P2 Treatment

> *"Eating healthy is important but as a college student it is a lot harder to manage. I am on a sorority meal plan to I kind of just eat what they have and sometimes it is not the healthiest option."* – Female, P1 Treatment

> *"I try to eat healthy, but sometimes I don't. I wanted something sweet so I didn't tell myself you can't have it."* – Female, P1 Treatment

Discussion

This study provides unique and comprehensive measures of shopper marketing insights related to different vending intervention strategies to inform a vending intervention in the college population. The measures of awareness, attitudes, and purchase of a specific item assessed at the point-of-purchase adds strength to the measures of overall sales or intended purchases commonly used in vending intervention research, which are not a clear indication of actual behavior at the individual level.[95, 117] These results suggest the addition of a point of purchase promotion to a product introduction (P2 treatment) with a vending intervention may not be associated with different awareness, attitudes, and purchase when compared to just the product introduction (P1 treatment). However, it should be noted that threats to validity, including a small sample size and project scope as well as noted intervention implementation fidelity issues, limit the conclusiveness of these results. That being said, we organized this discussion to first provide an evaluation the study limitations for consideration when reviewing the study results by primary outcome. While these limitations confine our ability to draw statistical conclusions from these study results, we hope our presentation of the methodology and lessons learned will assist future studies in conducting improved research to contribute to the limited knowledge and evidence in the area of point-of-purchase shopper insights research for vending machine interventions.

Limitations and Future Research

We chose to use intercept interviews at the point-of purchase to uniquely obtain accurate, real-time shopper insights on the awareness, attitudes, and actual purchases. However, this type of data collection led to a smaller sample size than some of the other studies that used overall sales data or broad surveys,[27, 62] with the small and uneven sample size potentially limiting the validity and reliability of results. Particularly, only having 13 interviews, with unequal numbers in each group and only four individuals in the P2 treatment, limited our ability to accurately assess the primary outcomes and compare the treatments. While we utilized data analysis techniques that accounted for these smaller sample sizes, concerns with representativeness of the sample and power to detect diffences still present threats to validity of results. While the small sample size may be related to the low repsonse rate, with only 39% of the 33 individuals who purchased a product agreeing to participate in the intercept interviews compared to 70% or greater response rates in previous studies,[92, 93] other similar studies in this population have found similar or lower response rates of 12-38%.[99, 192] However, these studies had a much larger sample to pull from, suggesting the sample size may be related more to the limited time frame of data collection used

in this study (discussed below) and/or issues with representativeness with this sample having a less frequent vending usage than other members of this specific population.[27, 92, 93]

Another concern that may be related to the smaller sample size is that potential lack of representativeness of the sample, which reduces the validity and generalizability of findings. For example, the majority of participants in this study (54%, *n*=7) indicating they purchase items from vending machines at the lowest frequency, or less than once a month, differs from previous studies with college student vending users where approximately 50% purchased items from vending machines at least once a week.[27, 62, 93, 99] In addition, the proportion of males in this study (62%, *n*=8) is higher than that of the study university (50%),[195] overall enrollment of all college students (44%),[19] and what is found in other similar studies including college student vending users (23-54%).[27, 62, 92, 93] In addition, Buscher, Martin, and Crocker found male college students were less likely than women college students to admit point-of-purchase promotions influenced their purchasing of a targeted healthful item,[174] though actual influence or behavior is unknown. In addition, while this study sample being majority white (77%, *n*=10) is consistent with the study university demographics (76%),[195] it seems to be less diverse than the overall target population of college students in the U.S. (57% white),[19] and that found in other studies (41%).[27] These differences in gender and race may have impacted the results, since gender and race have been shown to predict food preferences, choices, and reasons for choice as well as choices of dining locations in the college population.[162, 163, 165] This evidence suggests future studies should attempt to not only use a larger sample but also one that is more diverse and truly representative of the target population to further test these findings and improve the generalizability of these results.

While the purpose of this study was to gather exploratory shopper insights that can be confirmed with larger studies, the limited scope and reach of this vending intervention may impact the validity and generalizability of the results. The intervention scope was determined based on the ideas of Glanz, Bader, and Iyer suggesting implementing a small to moderate number of changes in availability may better direct consumers towards the healthier options, increase ability to determine individual product influence, and also reduce risk of potential profit loss associated with large changes in product availability.[117] However, the small scope of this project, only introducing one new product in a small sample of campus vending options (11%), may have limited its potential effect on the outcomes of interest. While the number of vending machines included was based on previous research in this population and expert input on the most popular locations,[92, 93] only including 11% of the total vending machines on campus may have limited our findings. In addition, our methods differed from previous research in that our limited resources and available researchers led to our observing one vending machine at a time compared to previous studies which collected data at all machines consecutively,[92, 93] reducing potential bias from confounding factors related to differences in time and dates. In addition, the times of our data collection only included four hours in the middle of the day, identified as most popular by students and vending representatives, whereas previous studies collected data for 12 hours, between 7 a.m. and 7 p.m.[92, 93] This difference in data collection times resulted in each machine being observed for 4 hours total (2 hours per treatment) compared to the 24-48 hours of total observation with previous studies. [92, 93] All of these differences in data collection introduced threats to validity by not only limiting our potential sample size, but also potentially reducing the representativeness of our sample since some vending users were likely not captured in the limited time frame. To improve upon these limitations, future research should expand the scope of the project to potentially include more substantial changes and obtain necessary resources and researchers for expanded data collection time frames to improve sample size and ensure the ability to accurately assess and compare the primary outcomes.

Some of the noted intervention protocol compliance issues may have also influenced the validity of the intervention impact and/or comparability of results. Only 38% (*n*=6) of the data collection timepoints and none of the interviews met all of the predetermined protocol. While we attempted to protect against any potential fidelity issues with each machine acting as its own control as part of the crossover treatment assignment, it is unclear whether these protocol issues may have impacted results. Nevertheless, the product being out of stock for one of the P2 data collection timepoints and interviews prevented our assessment the intervention impact in 25% of the interviews for this treatment due to the already limited sample size. In addition, all four P2 interviews had incorrect promotional placement at the bottom of the machine rather than at eye level due to the varying structural constraints of different vending machines. The noted inconsistencies in the availability and placement of the intervention product, as well as other available vending products, may have also led to other potential confounding external factors that may have influenced the results.[160, 161, 196, 197] Particularly, while we attempted to maximize visibility by placing the intervention product near other similar savory snacks such as nuts or crackers, we realized this placement made the intervention product appear to be more expensive comparatively, which was noted with the open-ended answers from participants. It is also unclear whether the presence of different or more snack options presented a confounding effect on whether participants chose the intervention product. Our main lesson from these fidelity issues was that more stringent rules and procedures should be put in place to ensure that all of the vending machines have the same structure as well as the exact and consistent stocking and placement of not only the intervention product and promotion, but also other item options available to avoid potential confounding issues.

Ultimately, to improve the intervention fidelity issues, we realized we needed to improve the partnership and communication with not only the university vending representatives, but also the third-party vendors in charge of monitoring and stocking the vending products,[190] a finding also noted by other studies in this population.[198] Particularly, potential success may have been improved by developing a mutually beneficial partnership with vendors which discussed the importance of ensuring appropriate product placement and stock in terms of what was important to the vendors, being increased potential profit.[190] While there are some resources available from the NEMS-V website on how to communicate and collaborate with vending representatives,[168] more guidance is needed on how to successfully promote and negotiate healthy vending interventions in a way that ensures their successful implementation. Lastly, while protocols were developed based on input from vending representatives, more research is needed to determine the ideal, and most feasible, protocols for implementing a vending intervention, taking into consideration the unique structure and challenges often found with this setting.[137]

Finally, the pre-experimental post-test only with a comparison group study design used with this study presents some additional uncontrolled variance and threats to validity.[160, 161] This study design aligns with our study goal of measuring differences between the two treatments or interventions, but has some limitations related to measurement and grouping that prevent it from being classified as one of the stronger forms of quasi-experimental or experimental study designs.[160, 161, 196] In addition, since the nature of questions asked presented potential risk of a carryover effect with the pretest measure potentially influencing participants' responses to the posttest, we accepted the ability of not being able to measure changes due to the lack of a pretest.[160, 161, 196] However, the nature of data collection resulting in self-selected groups, depending on when they visited the vending machines, rather than random assignment to groups, presents a potential selection bias where inherent differences in personal and behavioral factors between the groups, rather than the differences in intervention treatment, could have influenced the results and comparisons.[161] This is particularly true since the two groups in this study significantly differed

by BMI or weight status, which has been shown to be associated with differences in frequency of vending usage, influence of the advertising environment, and overall dietary habits among college students.[109, 164, 165] The low response rate of 39% in this study, combined with the limited sample size overall, also presents the potential for response bias, with it being unclear if those who completed the interviews differed from those who did not on the factors other than purchases, which were not significantly different between groups.[160] The use of a true experimental randomized control trial, which would improve the strength and validity of the study, is not aligned with our study goal to identify and evaluate realistic point-of-purchase shopper insights among participants since it would be conducted in a non-natural setting that may introduce additional bias with participant responses. However, future research could improve the overall study design by using experimental methods that would improve control for potential confounding biases related to issues with intervention implementation and consistency as well as selection bias by using randomization to groups or participant matching.

All of these limitations led to our inability to confidently draw conclusions from these results. However, we provide a discussion of our methodology and lessons learned as well as preliminary descriptive results from this study that can be tested and confirmed with future research that improves upon the previously discussed limitations. The previously discussed limitations should be taken into consideration when evaluating the interpretation, validity, and generalizability of these results.

Awareness

One potential reason for the low impact of this study may be related to participants' low awareness of the product, which has been identified as a major purchase barrier among shoppers.[190] Approximately 31% of the sample (n=4; P1 n=3, 33%; P2 n=1, 25%) saw the product in the vending machine during the time of observation. This measurement of the awareness of the product is unique among vending intervention studies, making comparison difficult. In addition, while 50% (n=2) of participants in the P2 treatment indicated they were aware of the promotion, our limited sample size in this treatment (n=4) limits the validity and conclusiveness of these results. It is likely that a larger sample size would have resulted in a lower awareness level similar to other studies with the college population in vending and other settings where 28-33% of students were aware of a point-of-purchase promotion labeling items as healthy as part of an intervention.[99, 174] In addition, these results differ from previous studies in cafeteria settings, which indicated point-of-purchase nutrition promotions were associated with a significantly higher awareness of healthy options offered as part of an intervention compared to a control with the same product availability but no promotion.[136, 192] While these findings may suggest the potential for unique factors in vending machines that may influence promotional effectiveness, the inconclusiveness of these results promote the need for larger studies and samples to investigate this idea further.

Participants suggested the lack of product and/or promotion awareness may have been related to the forced placement at the bottom of the machine rather than close to eye level as intended. While the predetermined intervention protocols attempted to correct for this by stipulating the product and promotion be placed near eye-level, issues with intervention protocol compliance related to structural constraints and inconsistencies led to the lower than desired placement. This poor visibility related to the location of the product is important because it has also been commonly identified as a barrier to purchase among shoppers.[190] Conversely, chips, which were the most commonly purchased item, were placed on the first and/or second row from the top at eye-level, likely increasing students' awareness of them. Placement as a potential explanation for awareness and purchase is consistent with the concept of choice architecture, where healthier choices and/or promotions are made more visible through placement at or near eye

level, which has then been shown to influence their purchase.[197, 199, 200] Previous studies have used choice architecture to place healthier items and promotional signs in vending machines, as well as other settings, finding it was associated with a significant increase in sales of those healthier items, without compromising revenue.[197, 198] The findings that approximately half (n=2) of participants in the P2 treatment group of this study who did not see the promotion indicated their awareness of the product and/or promotion would have influenced their intended purchases is also consistent with the choice architecture concept as well as previous study findings in this population and setting.[99] However, the concept of choice architecture and its potential influence is relatively new, with strength of studies usually being weak or moderate and more evidence needed regarding its influence on actual purchases in the college campus vending setting.[197, 199, 200] Furthermore, again, the limited sample size and fidelity issues with placement suggests the need for further research to compare and confirm these results.

Attitudes

Overall, approximately half of participants (*n*=6, 46%) indicated positive attitudes regarding the product. The open-ended answers indicated participants in both treatments perceived the product to be healthier compared to other items, despite the fact that only the P2 treatment provided a promotion with information on the health aspects of the product. The intervention product being new and different also seemed to impart both a positive and negative influence on participants' attitude and/or purchases of the intervention product. While some students indicated the product being new and unique to campus vending machines was as a reason for their interest in the product, a majority of individuals in this and other studies indicated they chose items and brands based on familiarity, usual habits, or cravings,[88, 92, 184, 194] which is not supportive of their purchasing a new item.[190] The product being new and unfamiliar combined with a potentially poor product description also seemed to inhibit students' purchase of it. Particularly, the three individuals in the P1 group who saw the product indicated they didn't purchase it due to their not knowing what the product was. These results suggest new products face unique barriers to introduction that may hinder attitudes for which additional strategies related to education and influence with promotion may need to be taken to overcome.[201]

Purchases

Purchases of the intervention product overall and during each treatment were low. The intervention product made up only 8% (*n*=3) of the total products sold during the observation time period, with all of these being during the product only (P1) treatment. The results indicating no significant difference in purchases with or without a point-of-purchase promotion has also been shown in other vending intervention research in the college population.[105, 131, 149, 189] However, it should be noted that the types, combinations, and scope of these interventions, including number of healthy items introduced and type of promotion used with the interventions, varied between studies, making comparison difficult. It is also interesting that these and other vending research findings are different from those in campus cafeteria settings, which found increases in purchasing of healthy items with nutrition point-of-purchase promotions added.[136, 192, 202] Overall, future research should take the previously discussed limitations into consideration and include a larger sample size over a longer period of time, in vending machines with consistent product availability and placement to control for confounding influences, to more appropriately compare the impact and trends in purchases with and without a point-of-purchase promotion.

While no participants in the product plus promotion (P2) treatment purchased the intervention product, two participants (50%) indicated the promotion would have influenced their purchase of the product had they been aware of it, while one participant (25%) who did see the

promotion indicated that it did not influence their purchase. This low potential impact or influence was also found other studies in the college population in vending and other settings where 31-43% of college students who saw a promotion indicated it influenced their purchase of the promoted product, compared to 57-100% in other settings and populations.[99, 174] In addition, we found participants that indicated they would be influenced by the nutrition promotion also suggested eating healthy was either moderately or highly important to them, while the participant that indicated they were not influenced suggested eating healthy was not important to them. This aligns with evidence from previous research that point-of-purchase promotions with nutrition information are most influential among those participants that are health conscious and motivated to eat healthy.[135, 142] However, more comprehensive research with larger sample sizes and validated measures are needed to confirm the valid and statistical relationship between these factors. Furthermore, the limited sample size in this study was unable to investigate the noted differences in perceived importance of healthy eating between different demographics, including higher importance in women, older individuals, and those with a lower BMI, with more evidence needed on how these might influence results in the college population.[135] In addition, other studies' with adults in restaurant settings also found promotions did influence both nutrition attitude and purchase intentions.[143] These results may suggest the need for different types of promotions to properly influence college students, with more research needed to determine what unique types of promotions or information are most influential in this population. However, the small sample size interviewed with the P2 treatment (n=4) limit any conclusions, with more in-depth research needed with larger samples to confirm any findings.

Vending Usage

While previous research in the college population has often asked hypothetical questions assessing intentions for vending purchases and choice,[92, 93, 99, 106, 119, 184, 194] this study has the strength of gathering shopper marketing insights at the point-of-purchase to gather more accurate, reliable, and realistic insights into vending machine usage.[88, 190] However, one realization from these shopper insights was that the product and promotion did not align with the participants' identified reasons for purchasing and choosing items from the vending machines, with this perceived irrelevance or interest potentially acting as a barrier to their purchase of the item.[190] The most popular reasons provided for purchasing items from vending machines were hunger, lack of time, and convenience and most popular reasons for item choice were personal preferences or habits, cravings, and lower price, which are consistent with previous research with the college population.[92, 93, 106, 184, 194] The motivations of hunger or skipping a meal and seeking items that were filling, which has also been shown in other studies in this population,[99, 114, 119, 184, 194] may explain some of the negative comments regarding the small packaging of the product, which deterred some from purchasing it. In addition, the small packaging, as well as the intervention product placement next to less expensive items, was described by some participants in this study as a reason for their perception of it being expensive, which does not align with the common reason for vending item choice in this and other studies being a lower price.[106, 184, 194, 203] Furthermore, the product promotion focused on the concept of health and nutrition, which has been shown to be an important factor in product choice among college students in similar studies.[74, 92, 184, 194] However, only two participants overall (15%) suggested their product choice was based on a product being less unhealthy than other items. In addition, only two participants in the P1 treatment (22%) indicated the product looked healthy, with no participants describing the product or promotion's health aspect in the P2 treatment, despite the availability of nutrition information for the product. One study by Buscher, Martin, and Crocker provides evidence for incorporating messaging related to the factors associated with food choice in the college population, where their

implementation of point-of-purchase promotional messages framed in terms of cost, convenience, taste, and energy in a cafeteria setting was associated with a significant increase in purchase of healthy snack items.[174] However, more research and testing should be completed to determine the influence of incorporating these aspects into point-of-purchase promotions in the vending setting.

This study sample using vending machines less frequently than what has been shown in other studies,[27, 92, 93] which may be related to sample representativeness, may also suggest students in this study and/or in the general college population are using other food venues commonly found on college campuses to seek food options. These potential competing options include campus convenience stores or restaurants, which often have a greater variety of options and are associated with less barriers to purchase, including issues with card reader payments or ability to inspect the nutritional value of individual products to determine their healthfulness.[108, 137] Observational field notes indicated some of these competing snack venues were in the same building as vending machines, making them even more convenient and accessible to students. However, the usage of these alternative food sources was not evaluated as part of this study, and the limited research available on these types of campus food venues overall makes their impact on vending usage unclear.[204] Future research should describe the availability of healthy options, sales traffic, and consumer characteristics of these alternative food venues for comparison to vending machines as well as investigate how their presence might influence the usage of vending machines.

Conclusion

The results in this study comparing the differences in awareness, attitudes, and purchase of an intervention product with and without a point-of-purchase promotion providing nutrition information are inconclusive due to a small sample size and study scope as well as fidelity issues that reduced the validity of findings. However, the unique measurement methods described as well as the comprehensive discussion of limitations can be used to inform and improve future research in this understudied setting and population. Additionally, the unique shopper insights gathered at the point-of-purchase that provide explanations for awareness, attitudes, and purchase as well as reasons for vending usage and choice can be used as a guide for further investigation with larger studies, where if confirmed, can be incorporated into future intervention strategies to increase relevance and potential success. Despite the study limitations, the overall lack of available research in the area of vending interventions in the college population, as well as on this specific type of snack product, indicate more testing is needed to better inform larger interventions and policies.

CHAPTER IV:
Frequency of Vending Machine Usage as a Predictor of Weight Status Among College Students

A version of this chapter was originally published by Morgan F. Sowers, Sarah Colby, Wenjun Zhou, Agricola Odoi, Elizabeth Anderson Steeves, and Katie F. Kavanagh:

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As first author, I was the primary contributor to the identification of study purpose and objectives, conception and design of the study, planning and collection of data, analysis and interpretation of the data, writing and revision of the manuscript, and submission to publication. The co-authors, as professors overseeing my work as a doctoral student, provided critical guidance in study design conception and data analysis procedures, as well as substantial revision of critically important manuscript content.

Abstract

Objectives: 1.) Compare college students' demographic characteristics by frequency of vending machine usage (FVU) and body mass index (BMI). 2.) Determine associations between FVU and BMI levels among college students. ***Participants:*** Convenience sample of college students (n=110) surveyed in January 2017. ***Methods:*** Participants completed an online survey providing demographic, height/weight, and FVU data. FVU was categorized as "lowest" (never/rarely), "mid" (< once/month), or "highest" (≥ once/month). Demographics were compared between FVU and BMI levels. Associations between FVU and BMI levels were investigated using a proportional odds logistic model. ***Results:*** The majority of participants were in the lowest FVU (50%) and normal BMI (56%) levels. BMI was significantly different by FVU levels (p=.012). Logistic regression indicated the highest FVU category was associated with a 4.5 times greater odds of being overweight or obese (p=0.001). ***Conclusion:*** There is a significant relationship between higher FVU and higher BMI among college students.

Background

College students experience a newfound freedom of choice associated with the college lifestyle, including in dietary choices.[21, 36] Unfortunately, this freedom often translates into the development of unhealthy eating patterns, excessive energy intake, and undesired weight gain.[3, 17, 18, 36] Currently, 35.1 percent of college students in the United States are overweight or obese,[4] which can lead to an increased risk of developing serious health conditions such as type 2 diabetes, heart disease, stroke, and certain types of cancer.[7] Furthermore, obesity prevalence of college-aged individuals has increased more than any age group and has more than doubled in the past 30 years.[6]

One dietary habit identified by college students as potentially influencing their weight status is frequent snacking.[25] Approximately 47 percent of the variance in weight gain among college students has been attributed to the frequency or amount of snacks consumed.[17] Furthermore, the number of snacks consumed per day and frequency of snack purchases away from home per week has been significantly associated with unhealthy dietary behaviors related to the development of an overweight or obese weight status.[46, 47]

Another aspect of the college lifestyle that influences dietary habits and weight of students is the campus food environment.[62] Purchasing foods on campus has been strongly associated with poor dietary habits, weight gain, and unhealthy weight statuses among college students, largely due to the unhealthy nature of items offered.[11, 62, 63] This holds true for vending machines on campus, where over half of college students report purchasing snack foods at least once per week,[27, 93] and majority of vending items are high in calories, sugar, fat, and saturated fat and low

in fiber.[27, 102] Vending machine customers recognize the unhealthy nature of vending machines, often identifying these machines as being a source of junk food or contributing to their weight gain.[26, 106] While availability of healthy items is important, consumers' choice of vending machine item may also play a role. Current research regarding the relationship between vending item choice and BMI in college students is inconclusive, with one study reporting no significant differences between item choice and BMI,[27] while another study only found a significant difference in BMI when participants purchased a chocolate bar item vs. another item ($p<0.05$).[110] Additionally, one study found that even when higher proportions of healthy vending items are available, college students choose the most unhealthy options the majority (59%) of the time.[93] However, the impact of vending item choice is mitigated by the fact that studies have shown the majority (approximately 93%) of all vending items are similarly categorized as unhealthy at the study university and other universities around the U.S.[97, 99, 101]

While evidence of college students' unhealthy vending item choices suggest more frequent snacking from campus vending machines might be related to higher weight statuses among college students,[17, 110] more research is needed to test and confirm this hypothesis. Though vending machines might be an ideal place for interventions in this population,[79] there is currently limited research available to inform these interventions. To our knowledge, the only other study that has investigated the relationship between frequency of vending machine usage and weight status was performed by Park and Papadaki and found no significant differences in BMI between groups of college students categorized as vending users and non-vending users.[27] Therefore, more evidence suggesting a relationship between frequency of vending usage and weight status is needed before introducing interventions with campus vending machines as a strategy to improve the diet and weight status of college students.[79]

Defining the target population prior to an intervention can improve the direction to better meet the needs of targeted individuals.[88] Specifically, more information is needed to describe demographic characteristics of college students who purchase items from campus vending machines at different frequency levels, especially related to differences in weight status.[27, 93]

Although, differences in BMI and snacking behaviors by sex and race have been observed in this population[5, 43, 205-207] there have been no studies that have assessed the association between FVU and BMI while also accounting for demographic characteristics. Therefore, the objectives of this study were to describe and compare demographic characteristics of a sample of college students by frequency of vending usage (FVU) and current weight status, measured using body mass index (BMI) and to determine the association between FVU levels and BMI levels, while controlling for sex and race. Based on limited previous research, it was hypothesized that participants with the highest FVU levels would have significantly higher odds of being overweight or obese compared to individuals with the lowest or mid FVU, when controlling for sex and race.[17, 110] The findings of this study provide evidence to support the need for vending interventions while also gathering information to inform these interventions.

Methodology

Study Design and Setting

This cross-sectional study was conducted in January 2017 at a university in the southeastern U.S.

Participants

The study population included a sub-sample of students (n=270) who previously participated in a larger research project and agreed to participate in future research. The

convenience sample was originally recruited for the larger research project using orientation tabling events, e-mail listservs, verbal classroom announcements, and postcards. As part of their participation in the prior study students took an online screener to determine eligibility. Eligibility requirements, based on needs of the larger study, were students at the study university who were first-year students in the 2015-2016 academic year and over the age of 18. To be eligible students had to have less than optimal fruit and vegetable intake and meet one additional criterion (first-generation college student, minority status, from low-income household, or had a parent who was overweight or obese). While the goal number of participants was 105, determined using *a priori* power analysis for logistic regression,[179] all 270 students were invited to participate in the study.

Data Collection

All 270 students were contacted by e-mail and asked to complete a short online survey using Qualtrics software.[166] They had 14 days from when the e-mailed link was sent to complete the survey. Reminder e-mails were sent on day 7 and 13 to students who had not yet completed the survey. The survey took approximately 10 minutes to complete and participants received a $10 gift card incentive after completion.

Variables and Data Preprocessing

The online survey asked participants multiple-choice questions regarding their demographics and FVU. Demographics included the dichotomous variable of sex; continuous variables of age, height, and weight; and categorical variables of race and academic class. FVU was measured by asking participants how often they purchase snack items from vending machines on campus, using a 6-point ordinal scale adapted from a previous vending usage study in this population.[93] Participants who never or rarely used vending machines were categorized in the "lowest" level, participants who used vending machines less than once per month in the "mid" level, and participants who used vending machines once per month or more in the "highest" level. Weight status was determined by utilizing self-reported height and weight to calculate the continuous variable of BMI.[180] The BMI values were also categorized into the ordinal levels of underweight (<18.5 kg/m^2), normal (18.5 – 24.9 kg/m^2), overweight (25 – 29.9 kg/m^2) or obese (>30 kg/m^2).[180]

For meaningful statistical comparisons and logistic regression, most of the categorical variables were re-coded by collapsing the variables into dichotomous variables to account for the expected small sample sizes in the minority categorical levels. Race was recoded into a dichotomous variable that included "white" and "non-white," with "non-white" combining all other race/ethnicities identified, including black, Hispanic, Asian, and other. Since the sample recruited included a majority of freshmen participants, the sophomore, junior, and senior categories were combined into an "upperclassmen" category. The BMI levels were collapsed into a simplified three-level categorical variable by combining the underweight and normal participants to create the "not overweight/obese" category, with the other two categories of "overweight" and "obese" being retained as originally categorized.

Statistical Methods

Descriptive Characteristics

Summary statistics, including means and standard deviations for continuous variables and frequencies and percentages for nominal and categorical variables, were calculated overall, by the three FVU levels ("lowest," "mid," and "high"), and by the three BMI levels ("not overweight/obese," "overweight," and "obese"). Before statistical comparisons were completed, the variables were analyzed for normality and small cell sizes. The continuous variables of age

and BMI were both considered to have a non-normal distribution according to the Shapiro-Wilk test (p <.001).[183] Therefore, median and interquartile ranges were used to provide descriptive statistics and a Kruskal-Wallis test was used to compare the average values for these variables between the three FVU and BMI levels. In addition, due to low cells counts, Fisher's exact test was used to compare the nominal and categorical variables between the FVU and BMI levels. Statistical significance was determined using a critical value of p<0.05. Data analyses for descriptive statistics were completed using SPSS, version 23.0.[208]

Logistic Regression

The choice of variables for consideration for statistical model was based on a developed logic model (Figure E.1), representing FVU and demographics as potential predictors of weight status in the college student population. A double-headed arrow between FVU and demographics denotes an expected correlation, but not necessarily a causal relationship. A proportional odds logistic regression model was used to determine the association between the ordinal dependent variable of BMI level and independent variable of FVU level. Both a simple model, with only the independent and dependent variables, and a multivariable model, that also included sex and race as potential confounding variables, were fitted to the data. The assumption of proportional odds for each variable was tested using a Wald test of parallel lines assumption.

Potential confounding by sex and race was assessed by comparing the change in parameter estimate of the variables in the model with and without the suspected confounding variable. A 20% change in the estimate of any of the variables already in the model was considered to be indicative of a confounder that was then retained in the model. [183] All two-way interaction terms were assessed for statistical significance and those significant at an $\alpha \leq 0.05$ were retained in the final model.

Odds ratio and 95% confidence intervals were computed for all variables retained in the final model. The critical values used for all significance tests was p<0.05. Data analysis for logistic regression were performed using Stata version 13.1.[209]

Ethical Statement

The Institutional Review Board at the study university approved all procedures prior to data collection. Before participation, all participants read and agreed to an approved informed consent. All data collected were de-identified before analysis.

Results

Descriptive Characteristics

A total of 110 participants completed the survey (Table E.1). The majority of participants were female (81%), white (81%), freshmen (69%), with a median age of 18 (IQR=[18, 19]). The majority of participants also had a BMI categorized in the normal level (56%). The median continuous BMI for all participants was 23.2 (IQR=[21.3, 26.6]) kg/m^2, which was also categorized in the upper end of the normal level.[180] Approximately half of the participants were in the lowest FVU level with the remaining participants in the mid (22%) and highest (21%) FVU levels.

There were no statistically significant differences in any of the demographics by FVU or BMI levels (Table E.1). However, statistical comparisons of BMI by FVU levels found a significant difference in the continuous BMI (p=.007) and the three BMI levels (p=0.012) between the three FVU levels (Table E.2). Specifically, the highest FVU level had the highest average continuous BMI (26.4 ± 5.2 kg/m^2), categorized within the overweight level, and highest proportion of overweight/obese BMI levels (59%).

Though not significant, some interesting findings can be drawn from the descriptive results provided for the FVU and BMI levels. More males were in the highest FVU level (45%) while more females were in the lowest FVU level (52%) than other levels, but the majority of both males (60%) and females (63%) were in the non-overweight/obese BMI category. The majority of white participants were in the lowest FVU level (51%) and the non-overweight/obese BMI category (66%), while the non-white participants were almost evenly split between the lowest (43%) and highest (38%) FVU categories and the non-overweight/obese (48%) and either overweight or obese (52%) BMI categories. The majority of both freshman and upperclassmen were in in the lowest FVU category (55%; 47%) and the non-overweight/obese BMI category (61%; 68%).

Logistic Regression

The final sample size for logistic regression was 109 after exclusion of one participant with missing data due to the choice of "choose not to answer" for the race variable. The non-overweight/obese BMI category was used as the base category for comparison. The reference categories of the independent variables in the model were the lowest FVU level, female sex, and white race. The Wald test of parallel line assumptions indicated none of the variables violated the proportional odds assumption (p=.342).

There was a significant association between FVU and BMI level. However, only the highest FVU level had a statistically significant association with the overweight or obese BMI levels in the final model (OR=4.46; p=0.001). Specifically, participants in the highest FVU were 4.5 times more likely to have a BMI in the overweight or obese levels, rather than the non-overweight level, compared to participants in the lowest or mid FVU levels.

The model results indicate that none of the demographic variables contributed significantly to the model and neither were they important confounders and so both of them were removed from the final model. There were no statistically significant interaction terms and so none were included in the final model (Table E.3).

Discussion

The purpose of this study was to describe the characteristics of vending users by frequency as well as provide evidence for FVU as a predictor of weight status, while considering potential demographic factors. The descriptive statistics provided an idea of the characteristics of college students who use vending machines with different frequencies. The biggest strength of this study was that it was the first to investigate the association between FVU levels and BMI levels, alone and while also controlling for specific demographic factors, in a college population. However, the novelty of this type of research makes it difficult to compare the results to prior research findings, limiting the potential confirmation for validity of the findings.

The first important finding from descriptive analysis was that the sample of students in this study used vending machines less frequently than previous reports of college students. This study sample consisting of approximately 50% vending users and 50% non-vending users was consistent with previous studies in this population;[27, 110] However, only 29% of participants in this study purchased items from vending machines at least once per month compared to 84% (n=294) of participants with this frequency in a similar study of college students.[93] This discrepancy might be due to the differences in sample size and demographic characteristics, with the previously mentioned study including 478 participants, 85% of which were students, with approximately half being female and race or academic year not measured, compared to our sample of 110 college students with a large majority being female, white, and freshmen.[93] In addition, it is unclear whether food availability or health policies differed on these campuses, which have been shown to influence vending machine usage.[27, 92, 99] Future research with a larger sample, additional data

collection, and multiple campuses should be conducted to determine if there is an overall decline in vending usage in this population or if the differences are due to other extraneous factors.[108]

Statistical comparisons of the demographic characteristics found no significant differences in FVU or BMI on many of the measured variables. Consistent with other studies, we found no differences in age or sex with FVU.[27, 93] However, this study further contributes to the comparison of demographic characteristics by FVU by also reporting no significant differences in race or academic class. However, there were significant differences in both the continuous BMI and dichotomous BMI levels between the different FVU levels. The significant differences in BMI between the FVU levels, with the highest FVU level having the highest BMI levels, contradict the previously mentioned findings from Park and Papadaki, which suggested there were no significant differences in BMI between groups of college students categorized as vending users and non-vending users.[27] However, the previous study used a higher frequency to define vending users, set at more than once per week compared to our highest FVU level being once per month or more, and was conducted in a different country and population, making comparison of results difficult.[27] These conflicting results suggest more consistent research is needed to confirm or refute this association.

The discovered differences between weight indicators and FVU levels supported the study hypothesis tested and confirmed with the proportional odds logistic model. Specifically, participants with the highest FVU level, or those that used vending machines once a month or more, had a significant, 4.5 times greater odds of being overweight or obese rather than normal weight, compared to participants with lowest or mid FVU. However, this does not prove a causal relationship between vending machine usage and weight status; instead, FVU may be a proxy for other overall dietary patterns not measured in this study. While there is little evidence to support the finding of weight specifically being related to vending usage, one previous study found individuals in the obese BMI group consumed snacks at a higher frequently than individuals in the normal BMI group ($p<0.05$).[210] Another interesting finding from this study was using vending machines at a mid-level, or less than once per month, did not significantly impact the odds of having a higher weight status. Overall, these findings support the use of specifying frequency when categorizing and comparing vending usage among college students.

Another particular strength of this study was the inclusion and testing of demographic variables in the conceptual and logistic model. Their lack of significant contribution to the logistic model indicated these variables may not be predictors or confounders that need to be controlled when determining associations between FVU and BMI. However, while not significant, the results may still provide insight into trends in the associations between sex and race and FVU or BMI. Though a higher proportion of males were categorized in the highest FVU level, associated with higher odds of being overweight/obese according to the logistic regression, neither males nor females were more likely to be overweight/obese in the statistical comparisons. Consistent with the logistic regression results of this study providing roughly equal odds of males and females for being overweight or obese compared to normal weight when controlling for FVU and race, current research in this population has provided conflicting results regarding which sex is more likely to be overweight or obese overall[205, 206] or consume more snacks per day.[43, 210] We also found that a higher proportion of non-white participants were in the highest FVU level and overweight/obese BMI level compared to white participants, though these findings are limited due to the small sample sizes in the non-white group and lack of statistical significance. However, previous studies have also indicated similar results, with non-white adults having a significantly higher obesity prevalence ($p < 0.01$)[5] and consuming significantly more snacks away from home ($p<0.01$) compared to white adults.[207] These findings were supported with the logistic model in this study indicating non-white participants having 67% higher odds of being overweight or obese compared

to normal weight than white participants, when controlling for FVU and sex. However, these interpretations of sex and race are limited due to the lack of significance with comparisons or logistic regression in this study.

Limitations

While this study provided novel information to expand upon evidence regarding vending usage in this population, potential limitations should be taken into consideration when interpreting the results. First, the cross-sectional study design only identifies associations rather than causal relationships. Only gathering data at one time point also leads to a lack understanding regarding changes over time or variances during different time points. Furthermore, the convenience sample commonly used in this and other cross-sectional studies could reduce external validity of the results. Specifically, the majority of participants being female, white, and freshman students may decrease representativeness of the sample and generalizability of results. The eligibility requirements for participation in the larger study from which the sample was taken, identifying participants "at risk" for weight gain may have also biased the results and reduced generalizability. Additionally, differences in the sample sizes within each level, with more participants in the lowest FVU and not overweight/obese BMI levels, may have reduced the ability to detect differences in these groups. A final limitation is that the sample was from a single university, with it being unclear whether food environment characteristics specific to this university may have influenced participants purchasing and consumption patterns in a way that is not consistent with other settings.[62, 79] Despite these limitations, this study was not intended to be a valid representation of all vending users, but rather an exploratory formative research investigation of associations that can be expanded upon with larger, more representative samples.

The survey data collection technique commonly used with cross-sectional studies may also present a limitation of this study. Particularly, relying on self-report of height and weight for the major outcome of BMI could lead to inaccuracies. However, studies have indicated self-reported weight in this population was strongly and significantly correlated with actual measurements.[211] That being said, female, white, and/or overweight or obese participants have an increased likelihood of underestimating weight and overestimating height, which underestimates BMI.[211, 212] Since this study was majority white, females, with unknown actual measurements, the resulting BMI, and subsequent logistic model analysis, should be interpreted with caution.

Finally, the scope of this study is limited in that it did not gather information on actual dietary behavior, including what types of items participants purchased from vending machines, which may act as an intervening variable between vending usage and weight status. However, previous findings suggest measuring vending item choice may not make a large difference due to inconclusive results on its effect on the outcome of BMI,[27, 110] the large homogeneity of unhealthy items present in vending machines on this and other college campuses,[97, 99, 101] as well as the homogeneity of college students' unhealthy choices, regardless of healthy item availability. Nonetheless, future research should measure, test and confirm the intermediate impact of vending item choice or dietary behaviors to determine the appropriateness of including this variable in the conceptual model testing FVU as a predictor of BMI.

Conclusion

The overall purpose of this study was to provide formative evidence that would contribute to the current lack of evidence regarding the relationship between frequency of vending machine usage and weight status in the college population. In doing so, we found a significant difference between measures of weight status with different frequencies of vending usage. Specifically, college students who purchased items from vending machines at least once a month had 4.5 times

greater odds of being overweight or obese compared to participants who used vending machines less frequently or not at all. Therefore, implementing healthy vending interventions could be beneficial for college students, with the largest impact on those who are already overweight or obese who are using vending machines most frequently. However, the results of this study should be interpreted with caution, due to the potential issues with representativeness of the study sample, issues with internal and external validity, and lack of current research to compare the findings. We suggest future studies expand upon our research to further test and confirm the association between FVU and BMI, while also incorporating additional confounding and effect modifying variables, to strengthen and build upon these findings. Finally, while this study did not seek to establish causation between FVU and BMI, future research should test the impact of interventions aimed at reducing the frequency of vending usage in this population on changes in weight status.

CHAPTER V:
Implementation of a Healthy Vending Intervention is Associated with Positive Changes in Perceived Healthfulness of Campus Vending Machines Among College Student Vending Users

Abstract

Objective: To measure the impact of a healthy vending intervention on college students' perceived healthfulness of campus vending machines and environmental, personal, and behavioral aspects of an intervention product. ***Methods:*** This study used a quasi-experimental, pretest-posttest, comparison group design to assess an intervention where a healthy dried bean snack product was added to 8 campus vending machines. Pre- and post-intervention online surveys assessed the primary outcomes of perceived healthfulness of campus vending machines (CEPS-Vending) and environment and consumption (attitudes and behaviors) related to beans (B.E.A.N. Survey) as well as secondary measures of demographics and intervention impact. Participants were categorized into vending and non-vending groups based on self-reported frequency of vending purchases. Analyses included comparing baseline demographics and primary outcomes between groups, and changes in primary outcomes from pre- to post-intervention within groups and between groups, controlling for intervening variables. ***Results:*** The sample included 71 participants (vending n=36; non-vending n=35). The groups differed significantly on weight status, CEPS-Vending and bean environment scores at baseline. Only CEPS-Vending scores were significantly different from pre- to post-intervention in the vending group (.61-point increase on an 8 point scale; p=.043). The vending group significantly increased their CEPS-Vending score from pre- to post-intervention by .723 points (p=.028) more than the non-vending group, after controlling for following a plant-based diet (F=4.574; p=.014). Intervention impact was low, with only 5 (7%) participants indicating awareness of the product. ***Conclusion:*** Introducing a small change in availability of healthy campus vending options with a pilot study was associated with a significant increase in perceived healthfulness of vending but not product-specific environment, attitudes, or behaviors.

Introduction

College is associated with lifestyle changes and newfound freedom for many students, including those related to dietary choices.[21, 213] Unfortunately, this freedom in choice often translates to development of unhealthy eating patterns, excessive energy intake, and undesired weight gain that can persist into adulthood and contribute to chronic disease risk.[3, 18, 32] One factor strongly associated with poor dietary habits and weight gain among college students is the potential influence of the college campus environment.[11, 62] Particularly, college students' poor dietary habits may be related perceived barriers to healthy eating associated with the campus environment, including low availability and higher cost of healthy options, lack of available time leading to higher intake of convenience foods, and lack of nutrition information identifying healthy foods.[70-73] These ideas relate to the social cognitive theory (SCT), which describes how an individual's behavioral, environmental, and personal factors interact to influence their actions and habits.[48] Ultimately, ensuring the campus environment is conducive to or supportive of students practicing healthy behavior is important because it can increase the likelihood of students making positive dietary choices.[48, 58, 132]

Specific places within the college campus environment where students are often influenced to purchase food due to their lack of time or need for convenience are vending machines,[90, 92] with studies indicating over half of college students purchased items from vending machines at least once a week.[27, 93] However, frequent snacking from vending machines on college campuses can lead to weight gain,[17, 110] possibly due to a majority of vending items being high in calories, sugar, fat, and saturated fat and low in fiber.[17, 27, 102] Furthermore, the Theory of Planned Behavior (TPB) suggests perceived ease or difficulty with performing a behavior, along with their attitudes and intentions, can predict actual behaviors.[49, 50] That being said, a large number of college students have noticed the lack of healthy products in vending machines and have often expressed desire for

increased availability of healthy options in this setting, stating it would help them to consume more healthful snacks and would make them want to use vending machines more.[90, 92, 96, 99, 113, 114] However, the few interventions in the college setting that heavily increased availability of healthy vending items have had mixed levels of success in terms of increasing sales of healthy items.[105, 116] One way to increase potential success of vending interventions in this population is to frame strategies in the SCT by incorporating environmental factors, including increased availability of healthful products, with personal factors such as attitudes and opinions about the healthful products included, to more effectively influence behavior.[48] In addition, it may be beneficial to assess and incorporate shopper marketing insights from students on where, how, and why they shop at vending machines to further increase relevance and impact of potential strategies.[190] For example, while college students have indicated they might change their usual vending snack food purchases if new and unique healthier items were introduced, [92] they also indicate their choices are not based solely on health, but also on taste and cravings.[71, 72, 92]

One healthy, unique vending item that would meet the desires of the students while also improving their dietary intake is a dried bean snack product. Preliminary studies found 60% of students surveyed perceived limited to no availability of beans on campus, with 30% of students wanting more beans available in quick and convenient ways.[120] Beans are a good option for a healthy vending item because they are underutilized, low-cost products that are excellent sources of protein, fiber, folic acid, potassium, and magnesium while being low in saturated fat.[123] This nutrient content is not only different from items usually found in vending machines,[102] but it also uniquely provides nutrients shown to be deficient in college students' diets while not contributing to their excessive saturated fat intake.[34] Studies have also found college students who consume higher amounts of bean products had higher bone density, lower blood pressures, lower body mass indexes (BMI), an indicator of weight status, and a reduced risk of becoming obese compared to those who did not consume beans.[34, 125, 126] Furthermore, 40% of college students in one study did not consume recommended amounts of beans,[120] with the average intake being only 40% of the recommendations.[34] This product is also desirable among the college population with 56% of college students in one study indicating they "like" or "strongly like beans" and 41 and 46% identifying taste and health, respectively, as reasons for their consuming beans.[120] Though introducing a bean snack product into vending machines seems to meet the dietary and personal preference needs of college students, further investigation is needed to determine college students' acceptability of specific types products before introducing them on a larger scale.

The purpose of this pilot study was to measure the association of a healthy environmental vending intervention introducing a healthful dried bean snack product in campus vending machines on students' perceived healthfulness of vending machines as well as perceived availability of beans on campus and bean consumption (attitudes towards beans and dietary intake of beans). These measures not only assess perceived healthfulness, which the TPB indicates could predict actual behaviors,[49, 50] but it also uniquely measures the environmental, personal, and behavioral factors as they relate to a specific product, which the SCT indicates interact to influence behavior.[48] To meet this purpose we aim to measure and compare these primary outcomes from pre- to post-intervention. For this aim, we hypothesized there would be a significant increase in the identified primary outcomes from pre- and post-intervention in a group of college student vending users. We also aimed to compare these primary outcomes between a group of vending machine users expected to be exposed to the intervention and a group of non-vending machine users not expected to be exposed to the intervention. For this aim, we hypothesized the group of vending users would have a significantly greater change in primary outcome scores from pre- to post-intervention when compared to the non-vending group.

Methods

Study Design

This study was conducted in a large university in the southeast U.S. This study design was a quasi-experimental, pretest-posttest with a comparison group design. The intervention involved stocking a bean snack product in a purposive sample of eight of the most popular vending machines on the study campus (11% of the 74 total campus vending machines). The product was a 0.75-ounce bag of a dried bean snack product and was priced at $1.00. The product was stocked in one arm of one vending machine, using standardized protocol, in each of the identified vending machine locations. The initial total intervention product inventory included 96 items with each of the eight machines stocked with 12 items at the start of the intervention in mid-January 2017. The intervention duration was intended to be 4 months, or the duration of the spring 2017 semester, with a planned intervention conclusion in mid-May 2017.

The product flavor, input on price and promotions, and the 8 vending machines chosen for this intervention were determined using formative research by this research group, conducted with members of this specific target population.[184, 194, 203] Two rounds of interviews using qualitative and quantitative methods were used to assess students' liking, preference, and potential influence of different product, pricing, and promotional strategies, with the highest scoring options chosen for this intervention.[184] The product flavor chosen for this intervention was liked and preferred by a majority of students in the target population sample, with 70% (*n*=42) indicating they would purchase it if it were in the vending machines on campus. Acceptability and influence of the price set for this product was also tested with the target population, with 87% of participants indicating the $1.00 pricing level would make them more likely to purchase the product,[184] with the price confirmed with approval from the product vendor. Finally, formative research determined the desired design and potential influence of point-of-purchase promotional materials providing product nutrition information for the intervention product.[184] However, further intercept interviews testing the promotion influence with vending users at the point-of-purchase found no significant differences in college student vending users' awareness, positive attitudes, or purchase of the product with or without the promotion present.[203] Therefore, the use of the determined point-of-purchase promotion was excluded from this intervention. The specific vending machines chosen for inclusion in this intervention were identified as the most popular locations using input from vending representatives and student researchers from the target population.[194] The content, sales traffic and consumer demographics at each of these machines were assessed using observational data collection and intercept interviews with student participants, with these data statistically compared to ensure no significant differences between machines.[194] Of the eight vending machines, four were in classroom buildings, two in residential halls, and two in office buildings.[194]

Study Sample

Participants recruited to participate in this study were from a convenience sample of students at the study university that were part of a larger project who agreed to participate in future research (*n*=270; 70% female). Our goal sample size for this study was 68 total participants completing both the pre-and post-intervention survey, which was determined using *a priori* power analysis (medium standard effect size $f^2 = 0.15$,[177, 178] α err prob. = 0.05, power = 0.8, *n* predictors = 2).[179] However, the survey was sent to the entire sample of 270 students to account for potential non-participation or attrition at follow-up.

Though all participants were assessed in the same manner, the participants were split into the two groups: vending users and non-vending users.[27] To determine group assignment, participants were asked to indicate their frequency of vending usage on a six-point scale adapted

from previous studies in this population,[27, 62, 93, 99] as part of the pre-intervention survey. Participants who indicated they "never or rarely" used vending machines were grouped into the non-vending group and participants who indicated they used vending machines "less than once per month" or more frequently were grouped as part of the vending group.

Data Collection Methods

Fidelity Testing

A group of trained student researchers collected observational data measuring the healthfulness of a purposive sample of 12 vending machine's contents using NEMS-V protocol.[65] This measurement acted as a form of fidelity testing to ensure the overall content and healthfulness of campus vending machines were consistent from pre- to post-intervention. A paired samples t-test was conducted to determine differences in the proportion of "healthy" items (categorized as "green" or "yellow")[65] from pre- to post-intervention at all locations.

Intervention Product Sales

Sales of the intervention product were monitored weekly throughout the intervention. The purpose of this data collection was to determine the intervention product success and stocking levels. Vending representatives were to provide weekly reports of the number of intervention products sold from the vending machines, still in stock, and restocked. Weekly observational estimates of the number of intervention products left in stock were also collected by the lead researcher as a check for the provided reports.

Online Survey

Data were collected using a pre- and post-intervention online survey administered to participants via e-mail using Qualtrics software.[166] Participants had one week from when the e-mailed link was originally sent to complete the survey, with a reminder e-mail sent on day four. The pre-intervention survey was sent to participants one week before the start of the intervention (mid-January 2017) and one week after the intervention conclusion (end of February 2017). The surveys took approximately 10 to 15 minutes to complete and participants received a $10 gift card incentive after completion of each survey.

The questions included in the online surveys served to measure the primary outcomes of perceptions of the healthfulness of campus vending machines and the availability and consumption of beans. These survey questions were adapted from two major data collection tools developed and validated by this research team – the College Environmental Perceptions Survey (CEPS)[107] and the Behavior, Environment, Attitudes, and Nutrition Knowledge (B.E.A.N.) Survey.[120] CEPS measures college students' perceived healthfulness of their college campus environment related to physical activity, healthy eating, water, policy, and vending.[107] This study only included the two questions to measure the perceived healthfulness of vending machines ("CEPS-Vending"), with the questions assessing perceived availability of healthier vending items and presence of promotional strategies to assist with identifying healthier vending options.[107] The total CEPS-Vending score was calculated by adding the scores for these two questions, measured on a five-point Likert-type scale, to give a total possible score between 0 and 8. The B.E.A.N. survey measures college students' bean consumption behaviors, perceived and desired environmental availability, attitudes towards beans, and nutrition knowledge related to beans.[120] The survey was used in this study to measure the perceived availability of beans on campus ("bean environment"), and attitudes and dietary behavior related to beans ("bean consumption").[120] The total bean environment score represented the score for one question, measured on a five-point Likert-type scale, to give a total possible score between 0 and 4. The total bean consumption score was

calculated by adding the scores of 7 multi-part questions, including 3 bean behavior questions assessing participants' frequency, variety and amount of beans consumed and 4 bean attitude questions assessing participants' attitudes regarding their preferences and reasons for consumption.[120] One small adaptation was made that replaced one of the bean options on an attitude question with fava bean to capture the intervention product. The total possible score for bean consumption was -36 to 81, which was transformed for data analysis to a new recoded possible score between 0 and 117.[120]

The secondary outcomes measured with the online survey included demographics, vending usage, and intervention impact. Demographic data included age, gender, race, academic class, and academic college of major. Height and weight were also collected to calculate a BMI score for each participant.[180] Finally, a question regarding dietary pattern practiced (omnivore, vegan, vegetarian, or pescatarian) from the B.E.A.N. survey was also included to assess this potential intervening factor that might influence bean consumption. Before data analysis, all of the categorical demographic variables were dummy or indicator coded to account for the expected small sample sizes in the minority categorical levels (Table E.1).

The variables measuring intervention impact on the post-intervention survey included the binary variables of "awareness" (did or did not see) and "purchase" (did or did not purchase) of the product from the vending machines on campus, the continuous "purchased frequency," (how many times they purchased the product) and the ordinal "product liking" (5-point Likert-type scale from strongly like to strongly dislike). An additional variable of "exposure" was determined by a question asking participants to indicate the buildings where they purchased items from vending machines most frequently, with responses not mutually exclusive. This variable was also dummy recoded in two groups of those that selected at least one location where the product was stocked and those that did not.

Data Analysis

The three ways in which data were analyzed included evaluation of between group differences in demographic characteristics and pre-intervention primary outcome scores at baseline; within group differences in primary outcomes from pre- to post-intervention; and between group differences in changes in primary outcome scores from pre-to post-intervention, while controlling for key independent variables. The participants with either missing data or those that selected the option "choose not to answer" were excluded from the individual analyses that included the variables in which they were missing data. Prior to statistical comparisons, normality of continuous variables were checked by examining the quantile-quantile (Q-Q) plot followed by a Shapiro-Wilk's test, where a p-value less than 0.05 indicated non-normality. If a continuous variable was not normally distributed, median and interquartile range were used to describe the variable and a Mann-Whitney U test was used to determine the differences of this variable between groups. For categorical variables, Pearson's chi-squared tests were used to determine differences between groups, unless there were expected cell counts of less than 5 in at least one cell, where Fisher's exact tests were used.

Between Group Differences at Baseline

Between group differences in demographics and primary outcomes with pre-intervention measures were compared between the vending and non-vending groups to determine any significant differences. Potential response bias was also evaluated by statistically comparing demographic variables provided with the pre-intervention survey between participants that completed the post-intervention survey and those that did not.

Within-Group Differences from Pre- to Post-Intervention

Within group differences between pre- and post-intervention scores for CEPS-Vending, bean environment, and bean consumption scores were analyzed overall and by group. If the data were normally distributed, a paired-sample T-test (and a Wilcoxon's matched pairs signed ranks test, otherwise) was used to determine the differences from pre- to post-intervention.

Between-Group Differences in Changes from Pre- to Post-Intervention

The between group differences in primary outcomes were evaluated using linear regression. These tests were conducted individually, testing one primary outcome at a time. Particularly, the change in scores between pre- and post-intervention for the primary outcomes of CEPS-Vending, bean environment, and bean consumption were used as the dependent variable and group membership as the primary independent variable, with the vending group acting as the indicator variable coded as one.

A multiple linear regression model was developed to assess the differences in changes in the outcome variables from pre-to-post intervention between vending and non-vending groups while controlling for a number of demographic variables. By using linear regression, the purpose was only to make predictive associations rather than indicate assumptions of causation. The potential indicator variables coded as one in the regression model for each of these previously dummy coded demographic variables included female gender, non-white race, freshman academic class, health-related academic major, plant-based diet, and overweight / obese BMI. In addition, potential interactions were tested by creating interaction terms between group membership and any significant independent variable by entering it in the model along with the main effects, with significant interactions retained in the final model. Since there were many independent variables whereas the sample size was limited, the variables were included using a stepwise method of entry, with the primary independent variable of group membership included with forced entry. Any variables that were significant were retained in the model. Backwards and forwards methods of entry were also used to check for possible variants of the final model. Once the model was selected, all of the assumptions of linear regression were tested including normality, homoscedasticity, and linearity, tested by evaluating the plot of residuals, and multi-collinearity tested using the VIF statistic and evaluating correlations between independent variables.

Finally, a multiple linear regression analysis was completed based on the final model chosen by the stepwise procedure to determine the intervention impact explained by various reaction groups (i.e., dichotomously coded variables that indicate "exposure," "awareness," or "purchased,"). Similar to previous methods, variables were selected by stepwise regression while the group membership variable was included with forced entry. Potential interactions were tested in a similar manner to the previous model. The results of adding these intervention impact variables to the model will be interpreted as additional effects on the primary outcome variable in each existing multiple regression model, when controlling for group membership and any other independent variables in the selected models.

Results

Fidelity Testing

A paired samples t-test indicated the overall average proportion of healthy items was not significantly different from pre- to post-intervention (t=-.231, p=.821).[65]

Intervention Product Sales

Evaluation of observed and reported stocking levels indicated the product was successful in terms of products sold. Specifically, 69% (*n*=66) of the initial 96 intervention products were sold within three weeks, with the intervention product being completely sold out of the vending

machines six weeks after the start of the intervention. Due to limited product availability, the product was not restocked in the vending machines. Based on these circumstances, a decision was made to conclude the intervention after six weeks, when the product was completely stocked out of the vending machines. The post-intervention survey was sent to participants at the end of February 2017, one week after the end of the six-week intervention.

Participant Characteristics

A total of 71 student participants completed both the pre- and post-intervention online survey, with 35 in the non-vending group and 36 in the vending group, for a response rate of 26% (Table F.1). A majority of participants were female (85%, n=60), white (76%, n=55), and freshmen (62%, n=44) with non-health related academic majors (75%, n=53). A majority of participants considered themselves to be omnivores (87%, n=62), eating a diet of both meat and plants. Of those in the vending group, almost half (44%, n=16) used vending machines less than once a month. The Shapiro-Wilk's test indicated none of the continuous variables were normally distributed (p<0.01). The median age was 19 with 89% being either 18 or 19 years of age. A majority of participants were in the normal BMI range (54%, n=38), with the median BMI being 22.8 kg/m^2. There were no missing data from any participants for any of the demographic variables, meaning all participants were included in this analysis. However, two participants, both in the non-vending group, were excluded from the analyses including CEPS-Vending scores due to their missing data on one or both questions in the pre-intervention measure.

Between-Group Differences at Baseline

The two groups had significantly different continuous BMI (p=.04) and BMI levels (p=.04) as well as CEPS-vending (p=.04) and bean environment (p=.04). Specifically, participants in the vending group had significantly higher BMIs and a higher proportion of participants in the overweight / obese BMI category, with 50% being in this category compared to 26% in the non-vending group. In addition, the non-vending group had significantly higher CEPS-Vending and bean environment scores compared to the vending group prior to the intervention.

There were 39 participants who only completed the pre-intervention survey and were therefore not included in the final analysis (data not shown). The only statistically significant difference between those who completed only the pre-intervention survey and those who completed both the pre- and post-intervention survey was academic class (p=.029). Specifically, a much higher proportion of the total upperclassmen in the sample completed both pre- and post-tests (n=27, 79%) rather than just pre-test compared to approximately half of the total freshman participants completing just the pre-test (n=32, 42%).

Within-Group Differences from Pre- to Post-Intervention

The CEPS-Vending scores in the vending usage group were the only scores that were significantly different from pre- to post-intervention, with a .61-point increase between these two time points (p=.043) (Table F.2). There were no significant changes from pre- to post-intervention in the bean environment or bean consumption scores overall or in either group.

Between-Group Differences in Changes from Pre- to Post-Intervention

The variables that were retained in the multiple linear regression models after stepwise entry included diet in the CEPS-Vending model (p=.021) and race in the bean consumption model (p=.040), with no variables retained in the bean environment model (Table F.3). After adding these variables, vending group membership was only significant with the CEPS-Vending model (p=.048). The CEPS-Vending model was also the only model that was significant overall, with the

highest adjusted R^2 value of .095 (F=4.574; p=.014). This model found individuals in the vending group significantly increased their CEPS-Vending score from pre- to post-intervention by .723 points more than the non-vending group, after controlling for practice of a plant-based diet (p=.028). The bean consumption model, while not significant overall, had an independent variable that was significant in the model. Specifically, those who identified as being in the non-white race group significantly decreased their bean consumption scores from pre- to post-intervention by 10.04 points more than those in the white race group, after controlling for vending group membership (p=.040). None of the interaction terms were significant in the model. All of the models met the key assumptions for normality, homoscedasticity, linearity, and multi-collinearity.

The overall measured intervention impact was low. Only 5 (7%) participants indicated they saw the product, with four in the vending group and one in the non-vending group. An additional 17 (24%) participants indicated they did not know if they saw the product, with 8 from the vending group and 9 from the non-vending group. Of those 5 participants who saw the product, 2 (40%) purchased the product, both of which were in the vending group. Of those who purchased the product, one individual purchased it one time and the other individual purchased it two times during the intervention time period. In addition, of those who purchased the product, one indicated they liked the product and one indicated they strongly liked the product. In regard to "exposure," to the intervention, 21 participants in the vending group (58%) identified commonly using vending machines where the intervention product was stocked. Due to the infrequent results for the intervention impact measures, only exposure, awareness, and purchase were tested in the regression model. When added to the model, no significant associations were detected with exposure, awareness, or purchase for any of the changes in primary outcome scores and therefore these measures were excluded from the model.

Discussion

This study is unique in that it incorporated and measured multiple factors that influence behavior, including the TPB factor of perceived behavioral control related to environmental influences,[49, 50] and the SCT factors of environment, personal, and actual behavior related to a specific vending product.[48] These measurements add strength to the common assessment of sales used in other vending intervention research,[27, 93, 95, 102, 105, 116] which does not provide a clear or holistic indication of actual dietary behavior.[95, 117] The results related to our first hypothesis using within group comparisons in pre- and post-intervention measures indicated the vending group did significantly increase their perceived healthfulness of campus vending machines from pre- to post-intervention, though there were no significant changes in the product-related measures. Related to our second hypothesis, this significant increase in perceived healthfulness of campus vending machines in the vending group was also significantly greater than the change in this measure in the non-vending group, after controlling for diet practiced, though no other changes in product-related measures were significantly different between groups from pre- to post-intervention. Finally, these results also provide insight into noted differences in characteristics between the vending and non-vending groups as well as differing demographic factors that may be associated with the primary outcomes.

One important finding is that vending users, but not non-vending users, significantly increased their positive perception of the healthfulness of vending machines from pre- to post-intervention. However, the low awareness of the intervention product (7%, n=5) limits these results in that it is unclear whether this improved perception was related to the intervention or other external factors. That being said, the perception of availability of beans in the environment actually decreased overall, and in both groups, though not significant, despite the small increase in available bean products in the vending machine. However, this measure of bean availability focuses on the

overall campus environment, rather than just the vending machines, which was not controlled for in this study. In addition, previous studies have indicated that some students may have been unaware of what the intervention product was or that it was a bean product, which could have influenced this score.[203] This notion is also supported by 25% (*n*=18) of the participants in this study being unsure if they saw the product or not. The dried bean snack product also being a new product and brand, not previously available in vending machines or other mediums at this university or geographic area, could have diminished its success with students who tend to choose items and brands they are familiar with.[88, 184] This may also help to explain the lack of significant change in bean consumption from pre- to post-intervention. Nevertheless, measuring actual dietary behavior specifically related to changes in vending options is a unique aspect that has been explored in only one other known study by French et al., who used food frequency questionnaires to measure changes in dietary quality before and after a vending intervention, and also found no significant changes.[132] This disconnect between perception and behavior was explored by Van Hulst et al., which found while increasing availability of healthy items with a vending intervention improved perception of healthy items available, there was no change in the participants' readiness to make a behavior change towards a healthy lifestyle.[128] This relates to the TPB factors of intentions and attitudes also being important to consider when determining the influence of perceptions in predicting behavior. [49, 50]

Another key finding of this study was the differences in weight status between the vending and non-vending groups. Specifically, the vending group had a significantly higher median BMI and a higher prevalence of overweight or obese individuals. This finding is also demonstrated in a previous study where higher frequency of vending usage was a significant predictor of higher BMI levels among students.[109] While studies have indicated frequent snacking from vending machines can lead to weight gain,[17, 110] it is unclear whether individuals with higher BMI levels are already more likely to use vending machines or if their vending usage is a partial causal factor to their weight status. In addition, it should be noted that the vending users in this study used vending machines at a relatively low frequency, with 44% (*n*=16) using vending machines at the lowest frequency of less than once per month. This may suggest inherent differences between groups or confounding factors other than vending usage may be related to the differences in weight status. Furthermore, the methods used in this study only tested associations rather than causations, which would need to be investigated with randomized experimental studies. In addition, despite the noted differences between groups, this study did not find BMI was significantly associated with any of the primary outcome results. The lack of current research investigating the relationship between weight status and vending usage, particularly related to perceptions and behavior, in this unique population of college students warrants the need for further study.

Interestingly, there was also a significant difference between vending and non-vending groups for the pre-intervention primary outcome scores focused on measuring perceptions of availability of healthy options (CEPS-Vending and bean environment). These results are not surprising for the CEPS-vending score, which evaluates the perceived healthfulness of the vending machines and would likely be different among individuals who frequently use vending machines compared to those who do not and may be unfamiliar with the offerings. However, the pre-bean environment scores being different between the groups was a surprising finding, especially since the groups did not differ significantly in whether they followed a plant-based diet. However, by using changes from pre- to-post intervention in our analysis, we were able to control for some of these differences between groups. More research should be conducted to determine the potential reasons for these differences, including how intervening factors that are also different between groups, such as BMI, may influence these perceptions.

One strength of this study is that it built on the limitation of other vending intervention studies by taking into consideration individual demographic characteristics which could influence how interventions are interpreted and utilized.[100, 135, 154] In doing so, we found while being in the vending group or non-vending group did not significantly influence the change in the primary outcome scores from pre- to post-intervention on their own, other demographic variables were associated with significant differences in some of these measures. Specifically, following a plant-based diet was positively associated with changes in perceived healthfulness of vending machines, when controlling for vending group. The lack of research related to plant-based diets and vending perceptions, or even vending usage, make it difficult to confirm these results. However, some studies comparing individuals following varying levels of vegetarian diets and non-vegetarian diets found they were associated with significant differences in nutrient intake profiles, including vegetarians having a significantly lower consumption of snack products and significantly higher intake of beans, legumes, and other plant proteins.[214, 215] Another unexpected potential intervening variable in this study was race, which had a significant negative association with bean consumption, when controlling for vending group. Differences in overall dietary attitudes between race groups have been documented in other studies that found food choices and reasons for food choice were significantly associated with different race groups in the college population.[162, 163, 165, 216] In addition, while a few studies have noted race differences in bean or legume consumption,[216, 217] there is limited evidence regarding differences between different races in attitudes and behaviors specifically related to beans, especially in the college-aged population. More research is needed to determine specific differences between all of the different races' dietary patterns as it relates to bean and other vegetable proteins, and the reasons behind these differences, to determine potential targets for improvement. Ultimately, future studies should incorporate a more diverse group of individuals, in terms of both diet and race to further test these associations with primary outcomes and get a true representation of the college population they hope to impact.

Limitations and Future Research

While this pilot study provides an example of a unique and comprehensive methodology and measurement strategy, future studies could make changes to the study design to further improve potential results. The specific convenience sample used in this study being majority female, white, and freshman students may potentially decrease the sample representativeness and generalizability of results. While we controlled for differences in demographics between groups, the overall sample having a large majority for gender, race, and age or academic class is important because these factors have been associated with significant differences in not only dietary choices and habits, but also weight status and weight gain, in this population.[18, 71, 72, 162-165, 211-213] In addition, the eligibility requirements for participation in the larger study from which the sample was obtained included that participants be "at risk" for weight gain, which may have also potentially biased the results and reduced generalizability. This pilot test also included an intervention and sample from a single university, where we attempted to control for intervention exposure and impact, but were unable to control for the overall food environment of the university and how it might have uniquely impacted the participants overall purchasing and consumption patterns.[62, 79] Despite these limitations, this study was not intended to be a valid representation of all vending users, but rather an exploratory pilot study used as a preliminary investigation of potential associations that can and should be expanded upon with larger, more representative interventions and samples.

Another limitation of this study is related to the groupings used for the vending and non-vending groups. The assignment of groups based on self-reported frequency of vending usage on a six-point scale was based on adaptations of methodology in other similar studies in this

population and/or setting.[27, 62, 93, 99] Specifically, defining those individuals that used vending machines less than once per month, which falls within the six-week intervention time frame, as vending users resulted in an approximately equal grouping of participants. However, the self-selected group assignment rather than random assignment may have led to other potential biases and uncontrolled threats to validity.[160, 161] For example, it is possible that factors unrelated to the intervention, including inherent differences in behavioral and personal factors between the groups, could have influenced the results. To control for this, future research could randomly assign participants to groups and/or match participants in groups based on potential confounding variables.[160] In addition, the fact that 44% (n=16) of the vending users used vending machines at the lowest frequency of less than once per month, which is different than previous studies where approximately 50% of college students purchased items from vending machines at least once a week,[27, 62, 93, 99] may suggest that this sample was not representative of true vending users. One potential way to correct for this skewed frequency is to revise the groupings in a way that more accurately captures true frequency of vending usage, as seen in a similar study that used three groups labeled lowest, mid, and highest frequency of vending usage.[109] However, this grouping would require larger sample sizes to balance and control for any differences in sample sizes between the groups.

The nature of the primary outcome variables being those that are self-reported could also influence the accuracy of data collected as a potential form of information bias. Particularly, the primary outcomes and some demographic variables that are related to perceptions, attitudes, or personal behaviors, pose a challenge to collect in a valid way other than self-report. However, the surveys used for the primary outcomes being validated with this population brings strength to this study.[107, 120] In addition, other studies conducted with this population and/or in this setting have commonly used self-reported measures for key outcomes, including behavior or consumption, purchasing, and demographics, including height and weight.[109, 116, 132, 192] However, while studies have indicated self-reported weight in this population was strongly and significantly correlated with actual measurements,[211] female, white, and/or overweight or obese participants, which make up a majority of this sample, have an increased likelihood of underestimating weight and overestimating height, which underestimates BMI.[211, 212] There is also the concern that these self-reported responses could be influenced by social desirability factors among participants. Therefore, future studies should attempt to obtain some of the demographic information from school records or conduct measurements of height and weight for BMI themselves to improve the accuracy and validity of results.

The small scope of the intervention is another limitation that could have restricted our influence or measurement of the intervention. We developed the small scope of this study, where limited quantities of one product was added in a sample of 8 vending machines for a limited amount of time, as a pilot test based on adaptations from previous intervention this population.[27, 93, 116] The purpose of this strategy was to correct the limitation of many other vending interventions who made large changes to their product availability, making it unclear which specific product(s) was associated with or influenced any resulting behavior change.[105, 116, 146, 148] We instead hoped to follow the advice of Glanz, Bader, and Iyer, who suggested implementing a small to moderate number of changes in availability to better direct consumers towards the healthier options, increase the ability to determine individual product influence, and reduce the risk of potential profit loss associated with large changes in new product availability.[117] However, the limited amount of product available led to a shorter than desired duration of the intervention, which could have also impacted results. While there is evidence of one study by Peterson et al. using a short duration intervention to successfully detect a change in college students' perception of healthy food items available, this study was conducted in a cafeteria setting and had promotional aspects that were

absent in this study.[192] Finally, as a pilot study, the product was only tested in a subset of vending machines (11%; *n*=8) rather than a system-wide change, which could have reduced the overall scope and impact across all university students. Additionally, while formative research in this population and university identified a specific subset of vending machines that were most popular among the general student population to test and stock the product in,[194, 203] these study results of the frequently visited vending machines identified locations that were not considered, potentially leading to missed opportunities for impact. Therefore, future studies should work with vending services to increase the scope, scale, and duration of a healthy vending intervention and retest and compare the effects on intervention impact or overall primary outcome measures.

Another limitation related to the small scope of the intervention that may affect the internal validity of the findings is the low measured exposure or overall intervention impact. Particularly, the exposure measure indicated only 58% of participants in the vending group (*n*=21) indicated they used vending machines where the product was stocked. Furthermore, 70% (*n*=49) of all participants, and 67% (*n*=24) of participants in the vending group, indicated they did not see the intervention product in the vending machines, which limits its potential influence on the primary outcome measures for those individuals. The potential impact is restricted further when considering the fact that only 5 participants (7%) saw the intervention product, with only 2 purchasing it (3%), one of which was an individual in the non-vending group. The inclusion of these variables in the regression models indicated they did not significantly influence the changes in primary outcome scores from pre- to post-intervention, when controlling for vending or non-vending group membership. However, the low frequencies of these intervention exposure and impact measures may suggest confounding or intervening variables, rather than the intervention, may be influencing the results. Future research should continue to include these measurements, as well as measurements of additional variables that may influence results, to appropriately test the potential for confounding and confirm the validity of findings. In addition, future research with larger samples could modifying the grouping of participants based on the measures of exposure and impact to conduct additional analysis that would confirm the internal validity of findings.

Finally, our decision to use a quasi-experimental study design rather than a true experimental randomized control trial was based on the purpose of the study being to determine realistic and actual changes in perceptions and behavior that could be generalized to real-world settings. Because of this, we wanted to conduct our study in natural settings rather than controlled settings that may have produced different and biased reactions or responses among participants. However, this choice of study design may have limited our internal validity, meaning that we were confined to conclusions of the intervention being associated with rather than causing changes in the primary measures.[196] In addition, the design including both pre- and post-intervention measures was the potential for carryover effects of the pre-test influencing ideas about the intervention or post-test responses, especially since these measures were self-reported.[196] Future studies should explore methods that introduce more control of extraneous factors that may influence an intervention, while still maintaining a natural setting to support generalizability, to improve the internal and external validity of study methods and conclusions.

Conclusion

This unique pilot study successfully measured the associations of a small-scale, short-term vending intervention on the changes in perceived healthfulness of vending machines as well as changes in environmental, personal, and behavioral factors related to a specific vending product. Results indicated the intervention group had significant changes in perceived healthfulness of the vending machines on campus, with a significantly greater change when compared to non-vending users, controlling for practice of a plant-based diet. However, more specific measures related to

perceived availability of beans on campus or bean consumption (measuring attitudes and behaviors) did not significantly change from pre- to post-intervention overall or in either group. In addition, intervening demographic factors including diet practiced and race seemed to be significantly associated with changes in key outcome scores, when controlling for vending group. However, the overall impact of the intervention was minimal, with few exposed or aware of the intervention product, likely due to a smaller scale and duration of the intervention. Future research should investigate the impact at a larger scale and longer duration as well as expand on results to determine whether increased perceptions ultimately lead to improvements in behavioral change in the long-term.

CONCLUSION

Overall, this project provided a unique opportunity to develop and implement a comprehensive, well-informed vending intervention strategy to improve the healthfulness of a specific element in the food environment. This was accomplished through five sequential phases of studies, with each study collecting data that informed the next (Figure G.1). The fundamental goal of this project was to provide a tested and practical strategy that can be used to make a small, but effective, positive change in the college campus food environment. We accomplished this by combining marketing research, which gathers preliminary consumer insights to develop and refine strategies to best meet consumer needs,[88] with behavioral research, which studies variables that impact habit formation including consumers' actual interactions with products.[218] In doing so, we were able to not only provide key insights and findings to contribute to the lacking evidence in this population and environment, but also provide examples of methodology for measuring different influential factors related to dietary behavior that can be applied in this and other settings.

This project aimed to develop strategies that addressed some of the limitations of current research in the college population. For example, we designed our project to take the entire SCT into consideration, considering not only environmental factors, but also personal factors, and how they impact behavior. [48, 57, 78] Specifically, the methods used in the preliminary research steps assessed consumer insights data on personal factors in this population, utilizing this data to inform and strengthen the intervention. Furthermore, we utilized measures that assessed environmental factors including the actual healthfulness, personal factors including individuals' perceptions and attitudes, as well as behavioral factors including their actual dietary and purchasing behavior. In addition, while vending intervention research commonly influences specific factors of the marketing mix 4 p's, [27, 65, 86, 90, 92, 93, 96, 102, 103, 106, 113] our research uniquely used methodology to determine the most ideal strategies for each of the 4 p's and then tested and compared their influence individually and in combination. Furthermore, previous vending research implementing large amounts of change in availability of healthy items makes it difficult to determine ideal healthy vending intervention products since the individual product influences are unclear. [105, 116, 146, 148] However, our small-scale intervention provided an example of methodology focused specifically on measuring the acceptability and impact of a new and unique individual product that can be replicated for other individual products in question. By addressing each of these limitations, we hope this project can inform future vending interventions in the college campus environment to improve their potential for success.

Some of the key findings from this project are those related to marketing research that provide evidence for the influential personal factors, including the perceptions and attitudes of the understudied population of college students, and environmental factors, including the characteristics and usage of campus vending machines. First, we provided insight into the reasons why college students utilize vending machines, including hunger, convenience, and lack of time,[184, 194, 203] which is consistent with other studies in this population.[90, 92, 98, 99] We also provided unique insight into specific marketing factors that commonly influenced college students' liking, preference, or purchase from vending machines, including the taste and health of a product, lower and convenient prices, and visually appealing and informative promotions.[184, 194, 203] We were also able to provide evidence regarding the description and comparison of vending machines in different locations, allowing the potential for catering strategies to different locations based on consumer characteristics or certain times of heavy sales traffic.[194] Particularly, residence hall locations seem to be a viable target due to the significantly higher usage among freshmen, which are at high risk for weight gain,[9, 17, 18] the lowest proportion of healthy items, and the easy 24 hour accessibility, especially when other food options are closed.[92, 97] These findings not only provide

generalizable evidence to inform future research, but also examples of methods for conducting formative research to inform a specific campus vending intervention.

Since changes to dietary behavior is the primary long-term outcome of a vending intervention, our findings also provided evidence for the last SCT factor of behavior, and those factors that influence behavior, using unique methods of behavioral research. Particularly, we measured not only purchases, but also awareness and attitudes, of the intervention product with different strategies, finding there were no significant differences in any of these measures with a developed point-of-purchase promotion with nutrition information.[203] We also found making a small change in the availability of healthy vending items with the introduction of the intervention bean snack product was associated with significant changes in perceived healthfulness of the vending environment among vending users overall and when compared to non-vending users, after controlling for diet.[219] Additionally, while the fast product sales indicated popularity of the product, our overall measured impact of the small-scale intervention was low, with a limited number of observed purchases or awareness of the product and no changes in the product-related environmental, personal, or behavioral measures.[203, 219] It should also be noted that these findings are related to a specific and unique vending intervention product, with more research needed on the generalizability of these findings. However, we were able to provide one generalizable finding related to behavior with analysis of baseline measures from the final study indicating a significant relationship between higher frequencies of vending usage and higher BMI level, with those individuals who used vending machines the most frequently having a 4.5 times greater odds of being overweight or obese.[109]

Through the comprehensive, multi-phase methods of this project, we were able to provide valuable insight into how to improve future vending intervention research in this population. Furthermore, we provide examples of how marketing and behavioral research can be combined to strengthen projects aimed at increasing purchasing behavior of healthier vending options in a way that mutually benefits consumers, retailers, and researchers. Beyond the findings of these studies, the methodology of assessing and incorporating all aspects of the SCT with joint focus on environmental, personal, and behavioral factors, is something that can be utilized in any setting to improve potential intervention success.

Study Limitations

When interpreting the findings of this project, it is important to take into consideration some of the limitations that were common among the studies conducted. Particularly, there were issues with the size and characteristics of the sample used, the nature of the measurements used, fidelity with the intervention implementation, and the overall limited project scope and research design. The implications of some of these limitations are that they have the potential to reduce the overall research validity, or the quality or merit of the studies, as well as external validity (generalizability) of the results, or the ability to extend or apply the findings to a broader population.[161, 196] Each of these limitations are discussed in more detail below along with suggestions for improvement on these limitations with future research.

First, the small and homogenous convenience sample used may have impacted the accuracy and generalizability of our results. While some of the studies in this project had samples that provided sufficient power, most of the studies had sample sizes that were lower than those found in similar studies in this population.[27, 88, 92, 93] These smaller sample sizes may have been related to the lower response rates of participants,[92, 93] the limited data collection time frames, and/or the less frequent vending usage in this specific population.[27, 92, 93] An additional limitation related to the sample was that the convenience sample used in all of the studies may have reduced the external validity of results. Particularly, the final study used a convenience sample of participants from a

larger study that were selected based on their higher risk for weight gain, which may have biased results and reduced generalizability. In addition, the convenience samples used may not have represented a true sample of vending users since the predominant frequency in which participants purchased items from vending machines was less than once a month, which is different than previous studies where approximately 50% of college students purchased items from vending machines at least once a week.[27, 62, 93, 99] Furthermore, the fact that only a few participants in our sample purchased the intervention product, despite a majority of participants in the preliminary phases of the project (70%, *n*=42) indicating they would purchase the product if it were in the vending machines on campus and the product selling out of vending machines faster than expect, may further indicate that we were surveying the wrong individuals. Finally, the lack of diversity in participant demographics may have also influenced results and reduced generalizability. This is especially true since gender and race have been shown to predict food preferences, choices, and reasons for choice as well as weight status and weight gain in the college population.[18, 71, 72, 162-165, 211-213] A final limitation is that the study sample and scope only included a single university, with it being unclear whether food environment characteristics specific to this university influenced participants purchasing and consumption patterns in a way that is not consistent with other settings.[62, 79] Overall, future studies should attempt to use a larger and more diverse sample from multiple different settings and universities that truly represents the target population to confirm and improve the generalizability of these results.

While the variety of sequential measurements used in this project might be considered a strength, the nature of some of the measurements used may also present some limitations. Particularly, while the self-reported nature of many of the measures in this project, including the primary outcomes and demographics, follow methodology of previous studies in this population and setting,[109, 116, 132, 192] they may still lead to accuracy and validity concerns. First, while the perceptual nature of the primary outcomes related to attitudes or personal behaviors pose a challenge to collect in a valid way other than self-report, the surveys used for data collection being validated with this population adds strength to these measurements.[107, 120] In addition, there are conflicting results regarding the accuracy of self-report of height and weight for the major outcome of BMI. While some studies have indicated self-reported weight in this population was strongly and significantly correlated with actual measurements,[211] others suggest female, white, and/or overweight or obese participants, which largely described our study samples, have an increased likelihood of underestimating weight and overestimating height, which underestimates BMI.[211, 212] There is also the accuracy and reliability concern with this and many of the other measures that individuals' responses could be influenced by social desirability, especially when the answers are given in-person as with the interviews conducted with some of the studies. To improve this, future studies could attempt to obtain some of the demographic information from school records or conduct actual measurements of height and weight. Another limitation of self-reported measures with the final study was the potential for carryover effects of the pre-test influencing ideas about the intervention or post-test responses.[196] One way to control for this carryover effect in future research is to use an alternative study design such as a Solomon four-group design or within-subjects crossover design.[196] However, these study designs require larger samples and are associated with additional challenges to intervention implementation that would need to be considered. Finally, while we attempted to collect additional observational measures to complement the self-reported measures when possible, including recording of actual purchases rather than self-report of purchases as used in previous studies,[19] this was not possible for some personal and behavioral measures. Future research should investigate other methods of objectively measuring and confirming personal and behavioral measures to improve accuracy and reliability.

Finally, issues with intervention implementation fidelity compliance with the final studies may have also influenced the reliability and accuracy of results. First, while an effort was made to place the product and promotion at eye level, following the idea of choice architecture,[197, 199, 200] the structural constraints of the vending machine prevented proper implementation of this protocol. Inconsistencies in the vending machine structure also led to variances in the exact placement as well as the availability of other products, which may have also introduced an external bias that influenced results. The limited product available also led to product stock outs during testing that prevented measurement of the true intervention impact in some cases. Finally, there is currently a lack of clear evidence for the optimal protocols for interventions in this setting or guidance on how to account for the unique structure and challenges of vending machines.[137] Future studies should determine ways to improve the appropriateness and consistency of vending intervention implementation to increase reliability and generalizability of results.

The limited scope intervention is another factor that may have influenced the intervention impact, results, and generalizability. The small scope of this project, where limited quantities of one product was added in a small sample of vending machines for a limited amount of time, was based on adaptations from previous studies this population.[27, 93, 116] However, only introducing one new product in a small sample of campus dining options, which only included 11% (n=8) of total campus vending machines, may have limited its potential effect on the outcomes of interest. In addition, the narrow focus on the intervention product and vending machines led to limited measurement and comparison of the product to other available products, overall or usual dietary intake, or other alternative food venues, which would have provided better context and framing for understanding and interpretation of results. The limited amount of product that was available for testing also led to a shorter than desired intervention duration, which could have also impacted results. Furthermore, we adapted methodology from previous research in this population and setting to first test the product in a subset of vending machines,[93] rather than implementing a system-wide change, which could have reduced the overall scope and impact across all university students. Only gathering data at one time point also means that we were unable to evaluate potential changes over time or variances during different time points. Therefore, future studies should work with vending services to increase the scope, scale, and duration of a healthy vending intervention and retest and compare the intervention impacts.

The final limitation of this project is related to the overall study designs methodology used, which were chosen based on the topic and nature of the research conducted. Specifically, our use of descriptive and pre- and quasi-experimental designs limited our internal validity, meaning that we were unable to determine if the intervention caused changes in our primary measures, but instead were confined to conclusions of associations.[196] A true experimental randomized control trial would have strengthened our studies' methods, and conclusions, especially as it related to the previously discussed limitations of external factors related to the intervention scope and implementation that were out of our control. However, since the purpose of the study was to determine realistic and actual changes in perceptions and behavior, we wanted to conduct our study in natural settings rather than controlled settings that may have produced different and biased reactions or responses among participants. It should be noted that the use of this natural rather than controlled design may have led to other potential biases and uncontrolled threats to validity resulting from the lack of randomization. This is particularly true with the group assignments of the final study, where factors that are not related to the intervention, including inherent differences in personal and behavioral factors between the groups, could have influenced the results. Improved group assignment that would control for these potential biases that could be employed with future research includes random assignment of participants to groups or matching participants based on characteristics that may be potential confounders.[160] Overall, future studies should explore

methods that introduce more control and consistency with testing, while still maintaining a natural setting, and compare groups based on random assignment to improve the strength of study methods and conclusions.

Lessons Learned and Future Research

To truly improve potential success of healthy vending interventions in the college population, it is important to also discuss critical lessons learned throughout the conduction of this project. Similar to the overall project theme, many of the lessons are related to the consideration and combination of both behavioral and marketing research. Specifically, while the *place*, *product*, *promotion*, and *price* used as part of the intervention with this project were chosen based on previous behavioral theory and research and informed by the target population, we realized specific limitations related to marketing and business with each of these factors that could be improved with future research. This includes vending potentially not being an ideal *place* for an intervention, the barriers related to the new and unique *product* chosen as the intervention focus, the lack of control over *pricing* levels or methods, and *promotional* techniques that lacked appropriate influence of the target market.

Place

The first lesson we realized is vending machines may not be the most ideal place of focus for an environmental intervention on a college campus. Vending machines were chosen due to their having the lowest perceived healthfulness of the environmental measures assessed with the CEPS survey, especially compared to other dining options.[107] Assessment of the actual contents of a sample of vending machines with this project also indicated the low availability of healthy products also made it an ideal target for intervention.[194] In addition, many students confirmed their main reasons for purchasing items from vending machines was the lack of time or need for convenience, both of which were noted major barriers to healthy eating in this population.[70-75] However, the lower than expected frequency of reported and actual vending usage noticed in this population limits the potential impact of a vending intervention, as seen with the results of this project.[219] Approximately 50% of student participants in this study indicated they used vending machines less than once per month compared the same proportion of college students using vending machines at least once a week, in previous studies.[27, 62, 93, 99] Future large-scale research should evaluate trends in vending usage over time as well as potential differences between different universities or regions to determine the potential reasons or implications for lower usage.

A potential reason for the lower frequency of vending machine usage could be the availability of other convenient food options on campus located in close proximity to vending machines. For example, we found campus convenience stores or fast food restaurants were located in the same building as three of the vending machines targeted with this project.[203] Specifically, the campus convenience stores act as a direct competitor for purchase of snack items that not only often have a greater variety of options, but they also accept alternative forms of payment, like student dining dollars, that may make them more desirable and convenient to students.[108] Few studies have evaluated the healthfulness or usage of convenience stores on college campuses, with no known comparisons to campus vending machines.[204] Future research should investigate if the presence of these and other alternative snack food sources impact the usage of vending machines or vice versa. This research should include gathering college students' perceptions of healthfulness or reasons for purchase and choice from these venues to compare to the findings from these and other studies regarding vending machines. Additional future research should determine if there are unique differences in the availability of healthy options, sales traffic, or consumer characteristics

of these alternative food venues compared to vending machines that may make them more or less ideal places for introduction of a healthy snack product for the college population.

Finally, the operation of vending machines usually being contracted to a third-party vendor leads to other unique barriers to implementing a vending intervention. While we were extremely grateful for the cooperation and participation of our university vending operators with this project, we realized we could have strengthened our intervention by first strengthening our partnership with these vending retailers.[190] We found regular engagement and communication with not only the university vending operators but also third-party vendors to be extremely important to ensure intervention fidelity, a finding also noted by other studies in this population.[198] For example, vending representatives' infrequent monitoring of vending machines may have led to some of the stock-out issues that could have potentially impacted results in this project. Communication issues related to indirect access to the third-party vendor may have also led to potential fidelity issues that could have been corrected, including the inadequate product stock as well as desired placement of the product in the machine. Lack of access to some vending information, such as overall vending sales and regular updates of intervention product sales, limited the potential data and comparisons we were able to provide. Our main lesson resulting from this collaboration was that we needed to not only consider our behavioral research aspect, but also implement shopper marketing principles of determining and demonstrating the mutual benefits of the project.[190] For example, the intervention product being donated meant that we reduced the risk of profit loss for vending representatives, making it more likely for them to agree to participate. However, we did not discuss with them the importance of ensuring appropriate product placement and stock, which was important to our intervention fidelity, in terms of what was important to them, being increased potential profit. Specifically, we could point to industry evidence that changing the product mix towards healthier snacks helped companies increase demand from new customers.[108] While there are some resources available from the NEMS-V website on how to communicate and collaborate with vending representatives,[168] more guidance on how to successfully promote and negotiate healthy vending availability, pricing, and promotion with vendors in the university setting should be developed and provided to improve potential success.

Product

The specific intervention focus being on one product that was new and unfamiliar to the target audience or venue of vending machines also seemed to be a barrier in this study. Our approach was to take the advice of Glanz, Bader, and Iyer and only change a small amount of the vending machine to determine the influence of a specific product and reduce undue risk of profit loss with large changes.[117] However, the low intervention impact we experienced with our sample led to a lack of conclusiveness regarding actual success in terms of behavior change. This leads to a potential feedback loop where large-scale interventions are likely needed to determine a difference in key outcomes and provide proven success, but many vendors are not willing to take the financial risk to implement a large-scale intervention without already having the proof of success. Future research should determine ways in which to test the impact of individual products with a healthy vending intervention using an appropriate scale and sample size to determine the ideal mix of products to include in a healthy vending intervention.

The specific product chosen being a dried bean snack product that is atypical compared to what is commonly found in vending machines may have also reduced potential impact of the intervention. The dried bean snack product was chosen based on it meeting student desires of being a new and different healthful product,[92, 119] that uniquely provides many of the positive dietary nutrients they are lacking.[34, 102, 120-124] Consumer insights from the B.E.A.N. survey also indicated a majority of students in this population wanted more availability of beans on campus in quick and

convenient ways[120] and liked beans because of their positive taste and the health, which aligns with the top reasons for choosing vending items in these and other studies.[74, 92-94, 110, 114, 119, 184, 194, 203] The preliminary results of this project also found that a majority of students liked the specific bean snack product introduced with the intervention, with a majority indicating they would purchase it if it were in the vending machines on campus.[184] In addition, the product seemed to sell well in the machines, with it selling out of stock earlier than expected. However, the product being different from what is typically found in vending machines is inconsistent with the findings that students' purchases or choices from vending machines are often dictated by their usual habits or cravings.[184, 194, 203] Therefore, future research should consider first implementing and testing common healthy products with vending interventions to establish initial success before introducing a new and unusual healthy product. Furthermore, the unusual nature of the product may also lead to difficulty with establishing points of parity, or minimum requirements and similarities between products, and points of differentiation, or characteristics that set it apart from similar items, for both consumers and marketers positioning the product.[190] These shopper marketing concepts suggest the inability to compare the intervention product might prevent consumers from selecting it over other products.[190] While this project did collect some insights related to attitudes of the product, more research is needed to determine perceived framing or positioning of the product compared to other offerings.[190]

The issue of the product being new and different is exacerbated by students being unfamiliar with the product, the brand, or even the type of product, all of which reduce potential purchase of the product.[203] This may be due to the product not previously sold in the vending machine format anywhere and it not being sold in any retail format in the geographical area of the intervention university. This unfamiliarity is important because low brand or product awareness is one of the most common shopper marketing purchase barriers that prevent products from being considered for purchase by shoppers.[190] While the low adoption rate of this new product by students overall seems to follow the normal product diffusion curve used in marketing research, more measurements as to which students may be innovators or early adopters, meaning they would be interested in the product early on, could have improved strategic targeting to potentially improve success.[220] A final indication we may not have chosen the correct product as an intervention focus is the fact that production and sales of the product were discontinued within a year after the intervention. If the product could not sell well in other more familiar venues such as grocery stores, it is unlikely that it would sell in the new venue of campus vending machines, where there are unique barriers to inspecting and selecting unfamiliar products.[137, 201] Future research should determine the best strategies for overcoming barriers to implementing new products in vending machines, including strategies for consumer targeting and progression through the new product diffusion curve.[220]

Price

While we assessed and attempted to manipulate pricing with this study, we were unable to dictate the actual pricing level of the intervention product or other products as part of this project. This is important because the price of vending items was commonly mentioned as a determinant of item choice among college students,[91, 106, 119, 184, 194, 203] with some indicating they would change their usual vending purchases if a new item were introduced at a lower price relative to the cost of similar items.[92, 129, 184] While participants in this study indicated the most desirable pricing level that would make them more likely to purchase the item was $0.75, feedback from the brand and vending representatives led the item to be priced at $1.00 to avoid potential profit loss and negative brand perception. However, our qualitative findings from one study in this project revealed the product size led to placement near other vending items that potentially influenced participants'

attitudes about the product.[203] Particularly, the product were placed next to crackers, which were less expensive, participants described a negative attitude or perception of the product being expensive compared to other items.[203] The product was also more expensive than the commonly purchased chips, which also had a much larger package.[203] These findings corroborate those from another study that found college students were not willing to pay more for healthier options, despite their indication that eating healthy snacks was important to them.[99] More research is needed to determine optimal pricing levels for vending items that appeal to both students and vendors, while also investigating and taking into consideration the impact of product placement and comparison to other items, student attitudes, and potential profit loss.

Another important finding of this project related to pricing was that while the amount was important to college students, the convenience of payment was just as much if not more important to some students.[184] Many students in one study of this project indicated a higher potential product price of $1.00 would be more desirable because they don't carry or want change,[184] a finding also documented in another study in this population and setting.[92] A related finding included 43% of participants in one of the studies in this project indicated they frequently use their student ID or a credit card to purchase items from vending machines.[184] This finding is important because field notes from one of the studies in this project indicated card readers on many of the machines were not functioning properly, often leading potential customers to not purchase any vending items after attempting to use the inactive card reader.[203] This limitation may make other food venue options such as the campus convenience stores that readily accept card and other payment methods a stronger potential contender for vending shoppers' business. Current research focuses primarily on payment amount with limited evidence available on the concept of payment convenience in this or any population. Therefore, more research is needed on the potential impact of convenience with different payment amounts of methods and how that might impact where and how consumers shop.

Promotion

Our promotional lessons are related to shopper marketing principles and considerations that should be implemented in addition to the marketing and behavioral research considerations we included. Shopper marketing builds a bridge between marketing and behavioral research by gathering insights into shoppers' habits and mindsets to understand where, how, and why consumers shop and leveraging this information to develop strategies that provide mutually beneficial benefits to all involved parties.[190] While our behavioral measures of awareness, attitudes, and purchase as well as environmental, personal, and behavioral factors align with the shopper marketing steps of stop (or attract), hold (or influence), and close (or motivate), incorporation of other shopper marketing principles to improve these strategies may improve future potential for success.

The first limitation to our promotional strategies is related to the first step of shopper marketing, building awareness of the product or stopping power of a promotion. Our overall low measured product awareness could be related to the structure and nature of vending machines introducing specific and unique barriers to promotion of specific items. First, the locations in which the vending machines are placed and structural design of the vending machines themselves make it difficult to implement point-of-purchase promotions in a way that would catch the attention of potential consumers. The design of vending machines also hinders the provision of individual-level nutrition information that would help consumers identify and compare the healthfulness of different products.[137] The structure of many vending machines forcing certain items to be placed in certain places may also have influenced results, with many individuals saying they didn't notice the product or promotion because it was placed low on the machine rather than eye level.[203] Conversely, vending items such as chips that were placed at eye level were purchased

most often.[203] Shopper marketing principles suggest poor visibility or location of a product is a common barrier that prevents the product from even being considered for purchase.[190] One way to correct this is by using the behavioral research concept of choice architecture, where healthy choices and/or promotions are more visible through placement at or near eye level, which then increases their potential for purchase.[197, 199, 200] While there is evidence for success of choice architecture in various settings or populations,[197, 199, 200] stronger evidence is needed to prove the potential of this strategy, especially with vending machines and the college population. Overall, more research combining ideas from behavioral and marketing strategies should be conducted to determine the best methods for maximizing awareness of new products in the unique shopping venue of vending machines.

The second limitation of our promotion suggests the importance of not only promoting awareness but doing so in a way that holds the interest of potential consumers by influencing positive attitudes regarding the product. For example, the results of one study in this project suggested the promotion was doing a poor job at describing what the product was on a basic level.[203] Many students in one study in this project who were aware of the product expressed confusion regarding what the product was, with many indicating this confusion was the reason why they did not purchase the item.[203] This again relates to the previously mentioned purchase barrier of low brand or product awareness impacting attitudes and inhibiting purchases.[190] These results suggest new products with little familiarity may require additional measures to overcome the unique barriers to introduction that may inhibit positive attitudes of the product.[201] Future research implementing a new product should determine the best methods for educating consumers about a product in a way that holds their interest, is meaningful to them, and stimulates positive attitudes that would promote purchase. A related limitation is that we only included point-of-purchase promotions rather than including messaging and information throughout the entire path to purchase.[190] Therefore, future research should evaluate additional types of promotions that reach customers before they are at the point-of-purchase, such as print or social media, including evaluating how they impact college students' interest and attitudes of a vending product.[190]

The final aspect of shopper marketing, the purchase or the close, is one we measured but could have improved by incorporating shopper marketing principles. Particularly, a potential reason for the low intervention impact may have been the product and promotion used not aligning with the participants' identified reasons for purchasing and choosing items from the vending machines.[190] This disconnect potentially made the promotion less relevant to potential consumers, which reduces its ability to positively influence product purchases.[190] For example, many participants' negative product comments were related to the small packaging and relatively expensive price, both of which contradict the most common reasons for vending purchases and choice found in this project and previous research.[92, 93, 106, 119, 184, 194, 203, 219] In addition, while the promotion provided nutrition information for the product to suggest its healthfulness, which was previously identified as important influence of choice among college students,[74, 92, 184, 194] few participants mentioned the product being healthy as a positive attitude regarding the product. These findings are important because shopper marketing principles indicate lack of interest or perceived irrelevance is one of the top barriers preventing shopper from considering the purchase of a product.[190] Future research should utilize both behavioral and marketing approaches to test the impact of incorporating messaging related to the factors most important to students when purchasing and choosing items in this unique setting of vending machines.

This project provides examples of how to combine marketing and behavioral research to strengthen methods, outcomes, and benefits for all involved parties. Particularly, we used marketing research consumer insights from college students to inform a behavioral research vending intervention on a college campus. While this strategy seems to be ideal for food

environmental research, it is not a common practice, with more research and learning required to determine the ideal way to incorporate these methods. Particularly, we realized that it is important to also take into consideration shopper marketing insights, including assessment and incorporation of where, how, and why consumers actually shop to increase connection between the theoretical ideas and measured actual behaviors. In addition, future research could potentially increase success and sustainability by not only focusing on marketing and behavior, but also taking into consideration the importance of ensuring mutually beneficial partnerships, especially as it relates to business aspects of a project. Ultimately, we hope to inspire continuous improvement in vending intervention research, especially as it relates to comprehensive measurement and positive influence of behavior, so growing evidence can eventually promote a positive shift in this food environment that encourages healthy dietary choices among college students.

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APPENDICES

A. INTRODUCTION

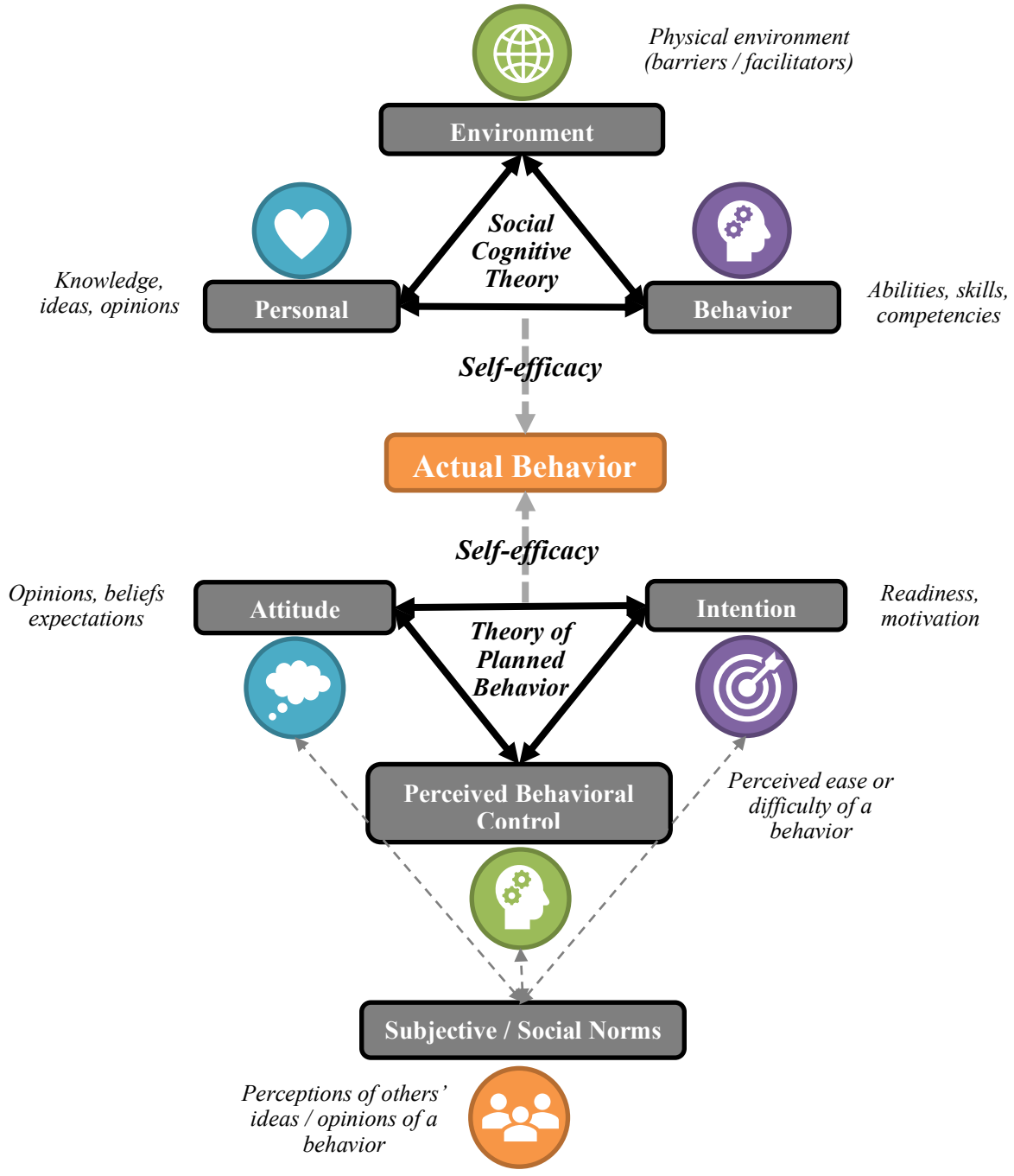
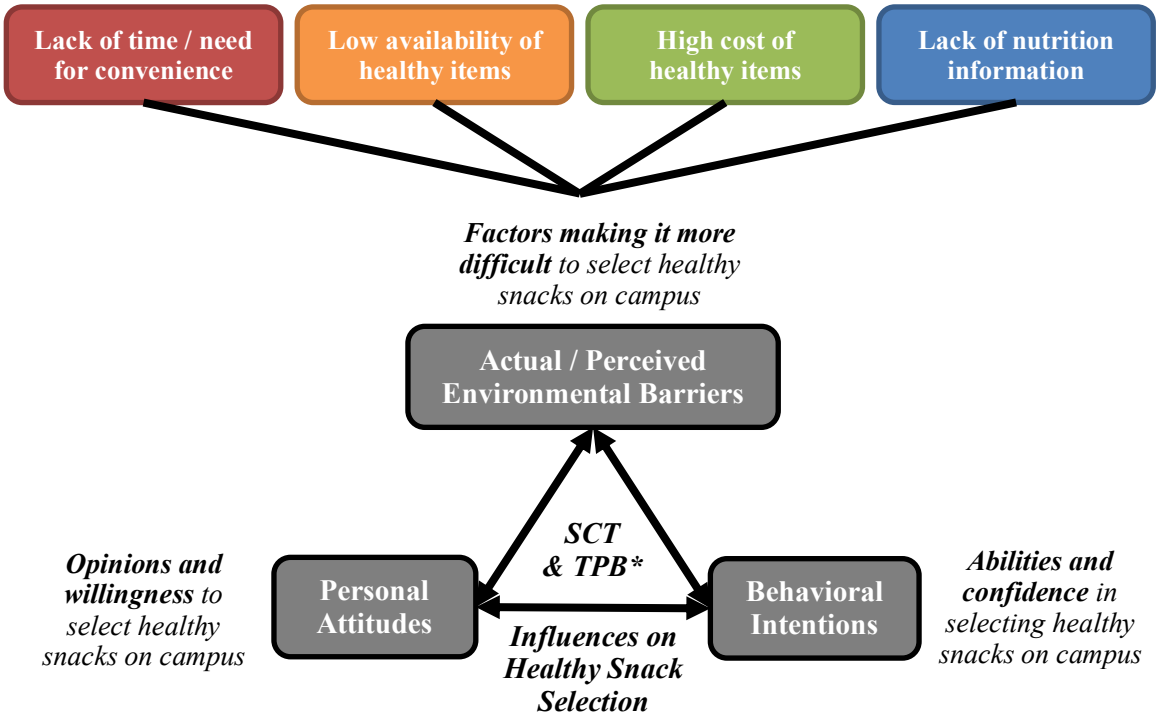


Figure A.1. Interactions and Influences of Theoretical Frameworks for Predicting Behavior



*SCT: Social Cognitive Theory; TPB: Theory of Planned Behavior

Figure A.2. Theoretical Influences Related to College Students' Selection of Healthy Snacks on Campus

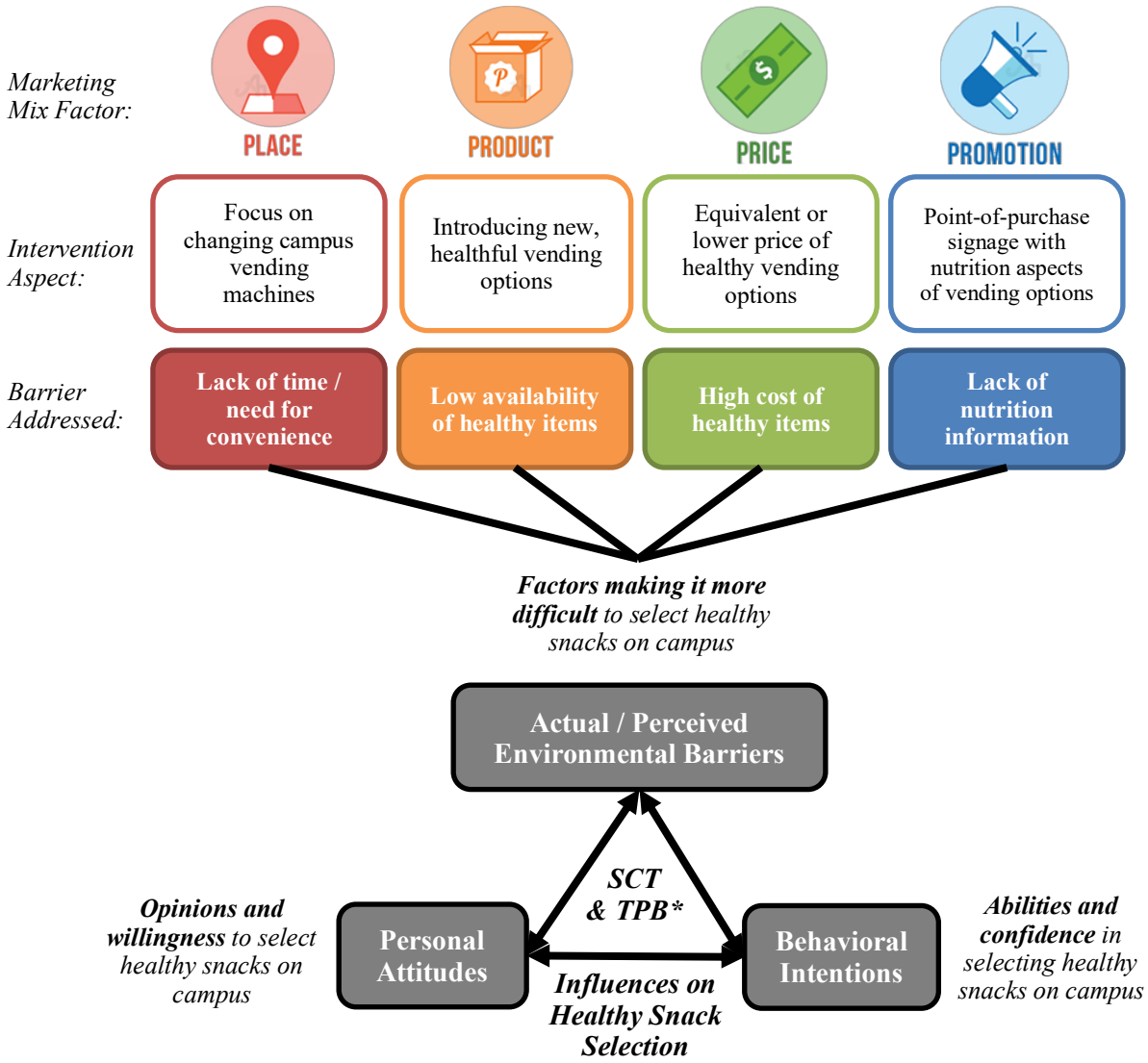


Figure A.3. Using the 4 P's of the Marketing Mix to Frame Interventions Focused on Improving Environmental Barriers to Healthy Snacking Among College Students

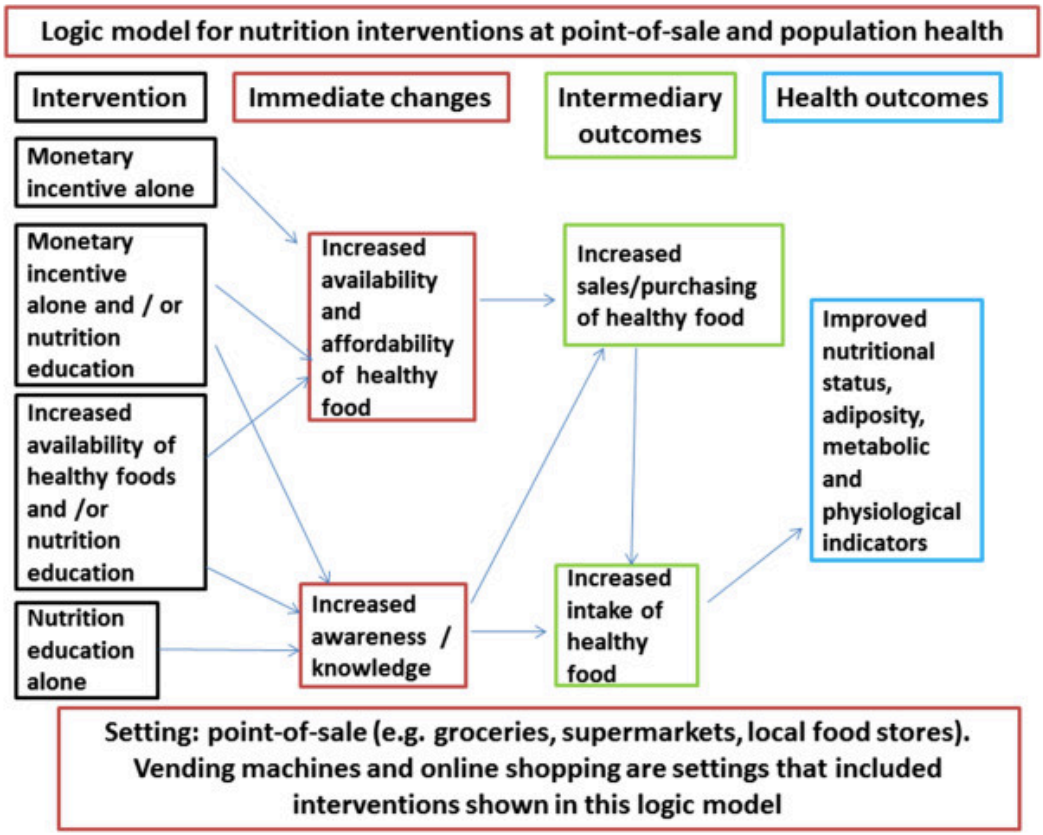


Figure A.4. Logic Model for Nutrition Interventions and Outcomes.[84]

B. CHAPTER I

Table B.1. Project Summary of Options Tested, Measurements, and Analysis for Key Outcomes with Each Phase.

	PHASE 1 *Exploratory* (n=30)	**PHASE 2** *Confirmatory* (n=30)
	PRODUCT	
Options tested	- "Sweet" - "Salty" - "Peppered" - "Spicy"	- "Peppered" - "Spicy"
Measurements	*Quantitative* - Liking rating[a] - Preference ranking[b] *Qualitative* - Probing questions asking to explain answers - What would make them like product more	*Quantitative* - Liking rating[a] - Preference ranking[b] *Qualitative* - Probing questions asking to explain answers - What would make them like the product more
Analysis	*Quantitative* - Sum of liking rating & preference ranking scores for all 30 participants (possible score 0-210) - 2 products with the highest scores retested with phase 2 *Qualitative* - Discovery of major themes	*Quantitative* - Sum of liking rating & preference ranking scores for all 30 participants (possible score 0-150) *Qualitative* - Discovery of major themes
	PRICE	
Options tested	open pricing, no set price options	- *$0.75* - *$1.00* - *$1.25*
Measurements	*Quantitative* - Perceived actual price (price they thought the product was) - Perceived expected price (price they thought the product should be) - Perceived influential price (would make them more likely to purchase the product) *Qualitative* - *Probing questions asking to explain answers*	*Quantitative* - Preference ranking[b] - Influence[e] *Qualitative* - What method of payment they use to purchase items from vending machines on campus - Probing questions asking to explain answers
Analysis	*Quantitative* - boxplot graph to produce a standard (median), lower (lower quartile), & higher (upper quartile) price to retest in phase 2 *Qualitative* - Discovery of major themes	*Quantitative* - Sum of liking rating and preference ranking scores for all 30 participants (possible score -30-90) *Qualitative* - Discovery of major themes

Table B.1. Continued

	PHASE 1 *Exploratory* (n=30)	PHASE 2 *Confirmatory* (n=30)
	PROMOTION	
Options tested	- "healthy item labels" - "healthy item categories" - "product nutrient information" - "product health benefits" - "additional product information"	- "specific nutrients" - "talking beans" - "health and flavor"
Measurements	*Quantitative* - Liking rating[a] - Preference ranking[b] - Influence[c] *Qualitative* - Probing questions asking to explain answers - What would make them like the promotions more / suggested improvements	*Quantitative* - Liking rating[a] - Preference ranking[b] - Influence[e] *Qualitative* - Probing questions asking to explain answers
Analysis	*Quantitative* - Sum of liking rating, preference ranking, and influence scores for all 30 participants (possible score 0-300) - 3 promotions with the highest scores retested with phase 2 *Qualitative* - Discovery of major themes - Revision of promotions to retest in phase 2	*Quantitative* - Sum of liking rating and preference ranking scores for all 30 participants (possible score -30-210) *Qualitative* - Discovery of major themes
	OVERALL AND VENDING USAGE	
Measurements	*Quantitative* - Likelihood of purchase[d] *Qualitative* - What would increase their likelihood of purchase - Reasons for purchasing items from vending machines - Reasons for item choice from vending machines	*Quantitative* - Likelihood of purchase[d] - What aspect makes them want to purchase or not purchase the item (taste, price, promotion, other) *Qualitative* - What would increase likelihood of purchase - Reasons for purchasing vending items - Reasons for vending item choice
Analysis	*Quantitative* - Total likelihood of purchase score[d] *Qualitative* - Discovery of major themes	*Quantitative* - Total likelihood of purchase score[d] - Frequencies for reasons for likelihood of purchase *Qualitative* - Discovery of major themes

[a] Liking rating measured on a 5-point Likert-type scale from strongly dislike (0 points) to strongly like (4 points)
[b] Preference ranking measured by ranking the option liked the least as 1 (0 points) to the highest option (n options – 1 points)
[c] Influence in phase 1 measured if the promotion would make them want to purchase the product; answer options included yes (2 points), maybe (1 point), or no (0 points)
[d] Likelihood of purchase asked if they would purchase the item if it were in the vending machines on campus; answer options included yes (2 points), maybe (1 point), or no (0 points)
[e] Influence in phase 2 was measured by asking if the price or promotion would make them more likely (1 point), neutral (0 points), or less likely (-1 points) to purchase the product from the vending machines on campus.

Table B.2. Summary Demographic Characteristics of Study Participants Overall and By Phase (*n* = 60).

	TOTAL (*n*=60)	**Phase 1** (*n*=30)	**Phase 2** (*n*=30)	
	Median [IQR]	*Median [IQR]*		*p-value*[a]
Age	20 [19, 20]	19 [18, 20]	20 [19, 21]	.082
BMI (kg/m2)	23.0 [20.9, 25.0]	22.8 [20.9, 23.9]	23.6 [20.7, 26.1]	.464
	n (%)	*n (%)*		*p-value*[b]
Race				1.00
White/Caucasian	48 (80%)	24 (80%)	24 (80%)	
Black/African American	5 (8%)	2 (7%)	3 (10%)	
Hispanic/Latino	2 (3%)	1 (3%)	1 (3%)	
Asian/Pacific Islander	3 (5%)	2 (7%)	1 (3%)	
Middle Easterner	2 (3%)	1 (3%)	1 (3%)	
Academic Classification				.121
Freshman	16 (27%)	12 (40%)	4 (13%)	
Sophomore	14 (23%)	6 (20%)	8 (27%)	
Junior	18 (30%)	10 (33%)	8 (27%)	
Senior	8 (13%)	0 (0%)	8 (27%)	
Graduate Student	4 (7%)	2 (7%)	2 (7%)	
Academic Major *(by college)*				
Agricultural Science/Natural Resources	3 (5%)	2 (6%)	1 (3%)	
Architecture and Design	1 (2%)	1 (3%)	0	
Arts and Sciences	21 (35%)	11 (36%)	10 (33%)	
Business	9 (15%)	4 (13%)	5 (16%)	
Communication and Information	5 (8%)	2 (6%)	3 (10%)	
Education, Health, & Human Sci.	9 (15%)	6 (19%)	3 (10%)	
Engineering	12 (20%)	5 (16%)	7 (23%)	
Nursing	1 (2%)	0	1 (3%)	
Other	1 (2%)	0	1 (3%)	

[a] Mann-Whitney U-Test conducted due to non-normal distribution of continuous variables
[b] Chi-square test of independence conducted
Note: Due to small cell size, race was recoded to white and non-white groups and academic year was recoded lower-classmen (freshmen and sophomores) and upper-classmen (juniors, seniors, and graduate students) before data analysis.

Table B.3. Summary Quantitative Scores of Product, Price, And Promotion Strategies from Phase 1 (*n* = 30) And Phase 2 (*n* = 30).

	Total Score [a]	Liking Rating Score [b]	Preference Ranking Score [c]	Influence Score[d]	Average Rating Score [e] *(M ± SD)*
PHASE 1					
Products					
Sweet	114	69	45	-	2.3 ± 1.1
Salty	91	60	31	-	2.0 ± 1.3
Peppered	130	77	53	-	2.6 ± 1.1
Spicy	130	79	51	-	2.6 ± 1.0
Promotions					
Healthy Item Labels	127	63	40	24	2.1 ± 1.1
Healthy Item Categories	177	82	62	33	2.7 ± 1.2
Product Nutrient Info.	166	86	78	42	2.9 ± 0.8
Product Health Benefits	115	55	35	25	1.8 ± 1.2
Additional Product Info.	223	88	85	50	2.9 ± 0.7
PHASE 2					
Products					
Peppered	90	74	16	-	2.5 ± 1.0
Spicy	84	70	14	-	2.3 ± 1.2
Prices					
$0.75	80	-	52	28	
$1.00	61	-	36	25	
$1.25	-3	-	2	-5	
Promotions					
Specific Nutrients	148	92	34	22	3.1 ± 0.8
Talking Beans	101	70	20	11	2.3 ± 1.2
Health And Flavor	142	91	36	15	3.0 ± 0.8

[a]Sum of liking rating, preference ranking, and influence scores. (phase 1 possible ranges: 0-210 for products, 0-300 for promotions; phase 2 possible ranges: 0-150 for products, -30-90 for prices, -30-210 for promotions)
[b]Measured on a 5-point Likert-type scale; total score is sum of 30 participants (phase 1 and phase 2 possible ranges: 0-120 for products and promotions)
[c]Measured by ranking options from least to most preferred; total score is sum of 30 participants. (phase 1 possible ranges: 0-90 for products, 0-120 for promotions; phase 2 possible ranges: 0-30 for products, 0-60 for prices and promotions)
[d]Phase 1: measured if option would influence product purchase (yes=2 points; maybe=1 point; no=0 points), (possible ranges: 0 to 60 for promotion); Phase 2: measured by asking if option would make them more likely (1 point), neither less or more likely (0 points), or less likely (-1 point) to purchase the product, (possible ranges: -30-30 for prices and promotions). Total score is sum of 30 participants for each phase.
[e]Total points possible ranged from 0 (strongly dislike) to 4 (strongly like)

Table B.4. Summary Scores of Price from Phase 1 (*n* = 30).

	Mean	Range	Minimum	Maximum	SD	Variance
How much do you think this product costs in the vending machines on campus?	$1.83	$2.75	$1.00	$3.75	$0.64	$0.41
*How much do you think this product **should** cost in the vending machines on campus?*	$1.46	$3.25	$0.50	$3.75	$0.68	$0.46
What price would make you more likely to buy this product from the vending machines on campus?	$1.03	$2.25	$0.50	$2.75	$0.42	$0.18

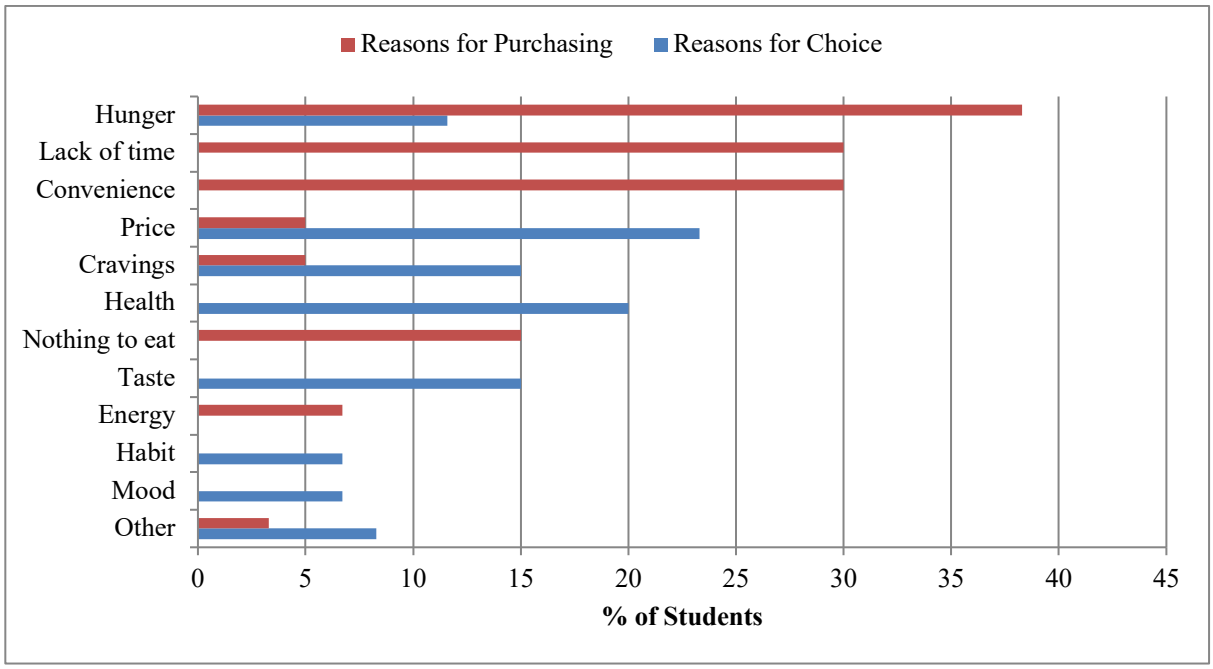


Figure B.1. College Students (*n* = 60) Reasons for Purchasing and Choice of Products from Vending Machines on a College Campus.

C. CHAPTER II

Table C.1. Frequency of Vending Machine Characteristics Collected with NEMS-V Data, Overall and by Vending Machine Location (*n* = 12).

	Overall (*n*=12)	Classroom (*n*=5)	Residential (*n*=4)	Office (*n*=3)
	n (%)	*n (%)*		
Location in Building				
Front Lobby	5 (42%)	2 (40%)	2 (50%)	1 (33%)
Hallway	2 (17%)	1 (20%)	1 (25%)	0
Break Room	3 (25%)	2 (40%)	1 (25%)	0
Outside	2 (17%)	0	0	2 (67%)
Hours Available				
24 Hours	6 (50%)	0	4 (100%)	2 (67%)
Working Hours	6 (50%)	5 (100%)	0	1 (33%)
In Working Order				
Yes	12 (100%)	5 (100%)	4 (100%)	3 (100%)
No	0	0	0	0
Cleanliness				
Acceptable	11 (92%)	5 (100%)	4 (100%)	2 (67%)
Not Acceptable	1 (8%)	0	0	1 (33%)
Advertising				
None	8 (67%)	4 (80%)	2 (50%)	2 (67%)
Green	0	0	0	0
Yellow	0	0	0	0
Red	4 (33%)	1 (20%)	2 (50%)	1 (33%)

Table C.2. Demographics and Consumer Characteristics (*n* = 111) Overall and by Location Type.

	Overall (*n* = 111)	**Classroom (*n* = 79)**	**Residential (*n* = 25)**	**Office (*n* = 7)**	
	Median [IQR]		*Median [IQR]*		*p* [d]
Age (years)	21 [19, 22]	21 [20, 23]	18 [18, 20]	20 [18, 22]	*<.001**
BMI (kg/m^2)	24.2 [21.7, 28.3]	25.1 [22.4, 28.5]	23.2 [20.4, 25.4]	23.6 [21.9, 27.3]	*.071*
Perceived Hunger	4 [2, 6]	4 [2, 6]	5 [3, 6]	3 [2, 6]	*.537*
Perceived Health	4 [3, 4]	4 [3, 4]	4 [3, 4]	4 [4, 5]	*.517*
	n (%)		*n* (%)		*p* [e]
Sex					*.845*
Male	46 (41)	33 (42)	11 (44)	2 (29)	
Female	65 (58)	46 (58)	14 (56)	5 (71)	
Race					*.327*[a]
White	96 (87)	68 (86)	23 (92)	5 (71)	
Non-White	15 (13)	11 (14)	2 (8)	2 (29)	
Academic Year					*<.001**
Freshman	24 (22)	5 (6)	16 (64)	3 (43)	
Sophomore	16 (14)	13 (17)	3 (12)	0	
Junior	19 (17)	14 (18)	4 (16)	1 (14)	
Senior	34 (31)	31 (39)	1 (4)	2 (29)	
Graduate Student	16 (14)	14 (18)	1 (4)	1 (14)	
BMI Level					*.043*[b]***
Not Overweight / Obese	62 (56)	38 (48)	19 (76)	5 (71)	
Overweight / Obese	48 (43)	40 (51)	6 (24)	2 (29)	
Vending Usage Frequency					*.903*
Low (<1 time/month)	32 (29)	22 (28)	8 (32)	2 (29)	
Moderate (1-2 times/month)	46 (41)	32 (41)	10 (40)	4 (57)	
High (1 time/week or more)	33 (30)	25 (32)	7 (28)	1 (14)	
Perceived Hunger					*.663*
Low (score 1-3)	49 (44)	37 (47)	8 (32)	4 (57)	
Moderate (score 4-6)	41 (37)	27 (34)	12 (48)	2 (29)	
High (score 7-9)	21 (19)	15 (19)	5 (20)	1 (14)	
Perceived Health					*.785*[c]
Poor / Fair	34 (31)	25 (31)	8 (32)	1 (14)	
Good	57 (51)	41 (52)	12 (48)	5 (57)	
Very Good	19 (17)	12 (15)	5 (20)	2 (29)	

*Significant at alpha < 0.05

[a] Combined black, Hispanic, and other race/ethnicities into "non-white" variable due to small cell counts

[b] Combined underweight and normal BMI levels into "not overweight/obese" variable and overweight and obese BMI levels into "overweight/obese" variable due to small cell counts

[c] Combined very poor, poor, and fair into "poor/fair" variable due to small cell counts

[d] Kruskal-Wallis test used due to non-normal distribution of variables

[e] Fisher's exact test used due to small expected cell counts less than 5 in some cells.

Table C.3. Participants' Vending Purchasing Behavior Overall and by Location Type (*n* = 111).

	Overall (*n* = 111)	**Classroom (*n* = 79)**	**Residential (*n* = 25)**	**Office (*n* = 7)**	
	n (%)		*n (%)*		*p*[a]
Reasons Vending Purchase*					
Hunger	68 (61)	51 (65)	12 (48)	5 (71)	.309
Lack of time	65 (58)	47 (60)	16 (64)	2 (29)	.257
Convenience	60 (54)	44 (56)	13 (52)	3 (43)	.849
Craving	38 (34)	26 (33)	11 (44)	1 (14)	.306
Price	7 (6)	5 (6)	2 (8)	0	.795
Other	4 (4)	4 (5)	0	0	.670
Reasons Vending Item Choice*					
Cravings	66 (60)	42 (53)	19 (76)	5 (71)	.104
Hunger	47 (42)	37 (47)	8 (32)	2 (29)	.399
Taste	44 (40)	30 (38)	11 (44)	3 (43)	.844
Price	32 (29)	19 (24)	11 (44)	2 (29)	.136
Habit	15 (14)	12 (15)	2 (8)	1 (14)	.628
Health/Nutrition	14 (13)	13 (17)	0	1 (14)	.061
Other	3 (3)	2 (3)	1 (4)	0	.643
Reasons for Potential Changes in Vending Purchases*					
Lower item price	67 (60)	46 (58)	17 (68)	4 (57)	.707
Healthier options available	61 (55)	47 (60)	11 (44)	3 (43)	.347
New, unique options	54 (49)	41 (52)	11 (44)	2 (29)	.492
Nutrition information available	18 (16)	12 (15)	4 (16)	2 (29)	.613
Other	3 (3)	2 (3)	1 (4)	0	.643

*Responses not mutually exclusive.
[a]Fisher's exact test used due to cell counts less than 5 in at least one cell.

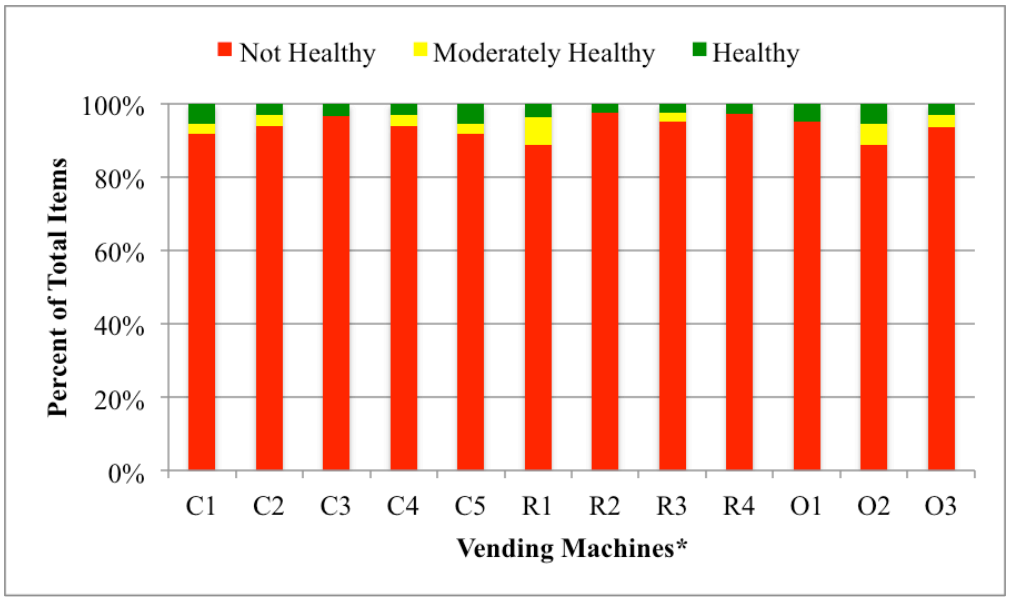


Figure C.1. Categorization of Healthfulness of Individual Vending Machine Contents using NEMS-V Criteria, by Location (*n* = 12).

**C = Classroom; R = Residential; O = Office*

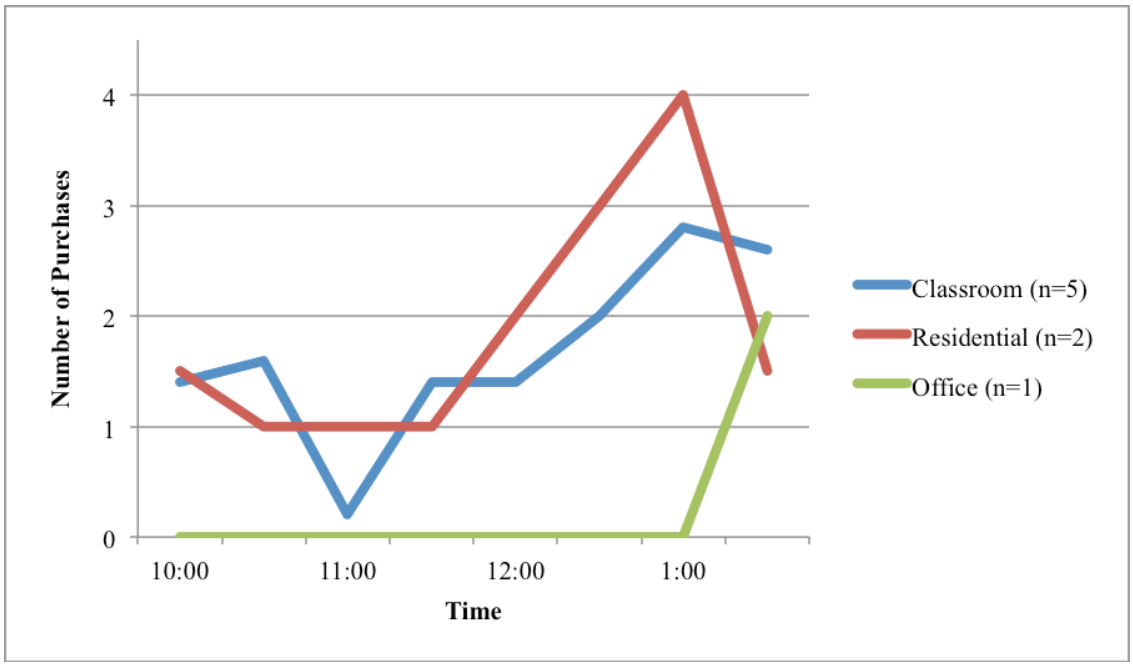


Figure C.2. Time Trend of Average Number of Purchases (*n*=99) Per Machine, by Vending Location Type.

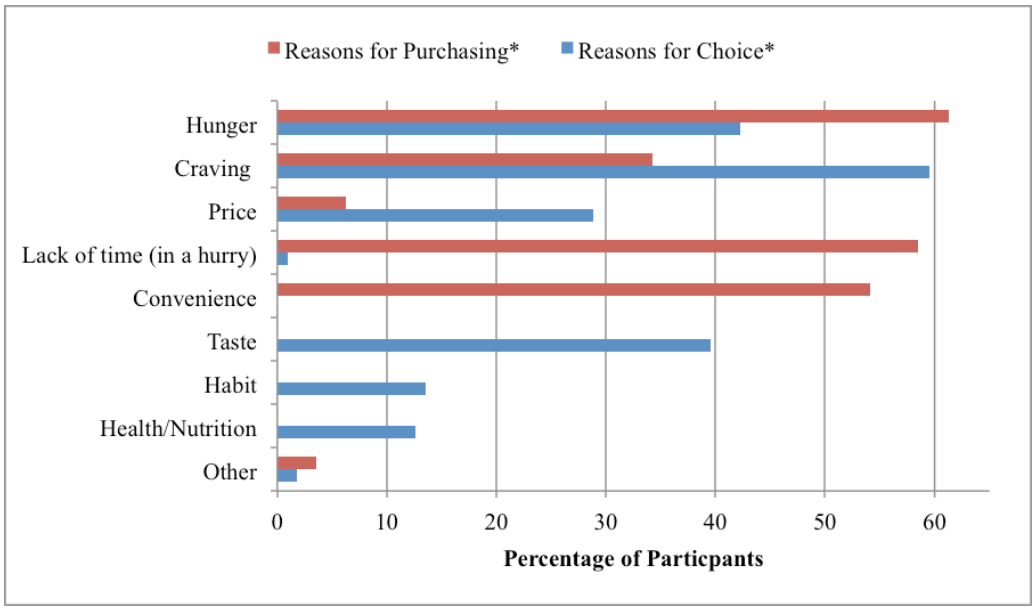


Figure C.3. Proportion of College Students (*n* = 111) Identifying Reasons for Purchasing and Choice of Items from Vending Machines on a College Campus.

D. CHAPTER III



Figure D.1. Promotional Signage Placed at the Point-of-Purchase During the Product Plus Promotion (P2) Treatment.

Table D.1. Intercept Interview Questions.

Question Category	Question	Answer Options	Outcome Measured
Screening	How often do you purchase items from vending machines on campus?	*a. Rarely/never* (skip to end of survey) *b. Less than 1 time per month* *c. 1 time per month* *d. 2-3 times per month* *e. 1-3 times per week* *f. more than 3 times per week*	Vending Usage
Current Vending Usage	Why did you visit the vending machine today?	Open answer	Vending Usage
	What did you purchase?	*a. Bean snack product* *b. Other*_____	Purchase*
	Why did you choose to purchase that item?	Open Answer	Purchase*
Product	Did you see the bean snack product in the vending machines today?	*a. Yes* *b. No* *c. Choose not to answer*	Awareness*
	What did you think of the bean snack product?	Open answer	Attitude*
Promotion[a]	Did you see the Kala bean snack product promotion on the vending machine today?	*a. Yes* *b. No* *c. Choose not to answer*	Awareness*
	What did you think of the promotion?	Open answer	Attitude*
	Did the promotion influence your purchase?	Open answer	Attitude*
	What aspect of the Kala bean snack product promotion influenced your purchase?	Open answer	Attitude*
Importance of Healthy Eating	Describe how important eating healthy is to you?	Open answer	Healthy Eating

Note: The bean snack product brand was included as part of the questions in the actual interview, but was blinded here for purposes of report.
*Primary outcome
[a]Promotion questions only included if P2 (product plus promotion) treatment was present

Table D.2. Intervention Fidelity Measures Overall and By Treatment Type.

	Overall	**P1 Treatment [a]**	**P2 Treatment [b]**	
Data Collection Time Points	*n*=16	*n*=8	*n*=8	*p-value*
Product Stock	15 (94%)	8 (100%)	7 (88%)	.302
Product Placement	6 (38%)	3 (38%)	3 (38%)	
Promotion Placement [c]	4 (50%)	-	4 (50%)	
All Protocols [d]	6 (38%)	3 (38%)	3 (38%)	
Interviews	*n*=13	*n*=9	*n*=4	*p-value*
Product Stock	11 (85%)	9 (100%)	3 (75%)	.308[e]
Product Placement	0 (0%)	0 (0%)	0 (0%)	
Promotion Placement [c]	0 (0%)	-	0 (0%)	
All Protocols [d]	0 (0%)	0 (0%)	0 (0%)	

[a] P1 Treatment = product only
[b] P2 treatment = product plus promotion
[c] N/A for some data collection so reduced n to 8 for data collection time points and 4 for interviews
[d] Number of data collection points that meet all applicable protocols (P1 treatment only needs to meet product stock and product placement).
[e] Fisher's exact test used due to small cell counts
*Significant at $p < 0.05$

Table D.3. Purchases by Product Category Overall, by Treatment Condition, and by Participation Group.

Product Category	Overall (*n*=36)	By Treatment Condition[a]			By Participation Group[b]		
		P1 (*n*=19)	P2 (*n*=17)		Participants (*n*=14)	Non-Participants (*n*=22)	
	n (%)	*n* (%)		*p*[c]	*n* (%)		*p*[c]
Intervention Product	3 (8%)	3 (16%)	0	.231	1 (7%)	2 (9%)	1.00
Chips	17 (47%)	5 (26%)	12 (71%)	.018*	5 (36%)	12 (55%)	.322
Crackers	3 (8%)	2 (11%)	1 (6%)	1.00	2 (14%)	1 (5%)	.547
Candy	6 (16%)	4 (21%)	2 (12%)	.662	4 (28%)	2 (9%)	.181
Pastries	7 (19%)	5 (26%)	2 (12%)	.408	2 (14%)	5 (23%)	.681

[a] Treatment group P1 = product only; P2 = product plus promotion
[b] Participation group Participants = purchased vending item and participated in interview; Non-Participants = purchased item and did not participate in interview
[c] Fisher's exact test of independence used for comparison due to small cells size.
*Significant at $p<0.05$

Table D.4. Summary of Participant Demographics Overall and by Treatment (*n* = 13).

	Overall (*n*=13)	Treatment Group [a] P1 (*n*=9)	P2 (*n*=4)	
	Median [IQR]	*Median [IQR]*		*p* [b]
Age	21.0 [20.0, 23.5]	21.0 [19.5, 23.5]	22.0 [20.3, 33.5]	.503
	M (± SD)	*M (± SD)*		*p*[c]
BMI	27.2 (5.3)	25.0 (4.1)	32.1 (4.72)	.019*
	n (%)	*n (%)*		*p* [d]
Gender				.490
Male	8 (62%)	5 (56%)	3 (75%)	
Female	5 (39%)	4 (44%)	1 (25%)	
Race				.371
White	10 (77%)	7 (78%)	3 (75%)	
Black	2 (15%)	2 (22%)	0	
Other (Arab American)	1 (8%)	0	1 (25%)	
Academic Class				.455
Freshman	0	0	0	
Sophomore	2 (15%)	2 (22%)	0	
Junior	5 (39%)	2 (22%)	3 (75%)	
Senior	3 (20%)	2 (22%)	1 (25%)	
Graduate Student	3 (20%)	3 (33%)	0	
BMI Categories				.091
Normal	7 (54%)	6 (67%)	1 (25%)	
Overweight	1 (8%)	1 (11%)	0	
Obese	5 (39%)	2 (22%)	3 (75%)	
Vending usage				.677
< 1 time per month	7 (54%)	4 (44%)	3 (75%)	
1 time per month	0	0	0	
2-3 times per month	2 (15%)	2 (22%)	1 (25%)	
1-3 times per week	3 (20%)	3 (33%)	0	
> 3 times per week	1 (8%)	1 (11%)	0	

[a] Treatment group P1 = product only; P2 = product plus promotion
[b] Mann-Whitney U test used due to non-normality of age variable
[c] Independent samples t-test used due to normality of BMI variable
[d] Fisher's exact test used due to low cell counts <5.
*Significant at $p<0.05$

Table D.5. Comparison of Primary Outcomes by Treatment.

	Overall	Treatment [a]		
		P1	P2	
Product	*n*=13	*n*=9	*n*=4	*p-value*
Awareness [b]	4 (31%)	3 (33%)	1 (25%)	1.00
Attitude [c]	6 (46%)	5 (56%)	1 (25%)	.559
Purchase [d]	1 (8%)	1 (11%)	0 (0%)	1.00
Promotion	*n*=4	*n*=0	*n*=4	
Awareness [b]	2 (50%)	-	2 (50%)	
Attitude [c]	3 (75%)	-	3 (75%)	
Influence [e]	2 (50%)		2 (50%)	

[a] P1 Treatment = product only; P2 treatment = product plus promotion
[b] Number of participants who indicated they saw the intervention product / promotion
[c] Number of participants who indicated positive opinions or attitudes of the intervention product / promotion
[d] Number of participants who purchased the intervention product
[e] Number of participants who indicated the promotion did or would influence their purchase of the product

Table D.6. Coding Frequencies for Open-Answer Explanations.

Concept	Overall (*n*=13)	P1 (*n*=9)	P2 (*n*=4)
	n, %	*n, %*	*n, %*
Vending Usage (*Reasons for Vending Purchase*)	• Hungry (6, 46%) • Skipped / replace meal (5, 38%) • Snack / meal complement (3, 23%) • Convenience / accessibility (2, 15%) • Lack of time (1, 8%)	• Hungry (4, 44%) • Skipped / replace meal (4, 44%) • Snack / meal complement (3, 33%) • Lack of time (1, 11%)	• Hungry (2, 50%) • Skipped / replace meal (1, 25%) • Convenience / accessibility (2, 50%)
Vending Usage (*Reasons for Vending Choice*)	• Cravings (sweet / salty) (6, 46%) • Personal preferences / habit (5, 38%) • Filling (3, 23%) • Less unhealthy (2, 15%) • Cheap price (2, 15%) • Interest / intrigue (2, 15%)	• Cravings (sweet / salty) (4, 44%) • Personal preferences (4, 44%) • Filling (3, 33%) • Less unhealthy (1, 11%) • Cheap price (1, 11%) • Interest / intrigue (1, 11%)	• Cravings (sweet / salty) (2, 50%) • Interest / intrigue (1, 25%) • Less unhealthy (1, 25%) • Cheap price (1, 25%)
Awareness (*Product)*	• Overlooked (3, 23%) • Low placement (2, 15%)	• Overlooked (2, 22%) • Low placement (1, 11%)	• Overlooked (1, 25%) • Low placement (1, 25%)
Attitude (*Product)*	*Positive* • Appetizing (3, 23%) • New / different (3, 23%) • Healthy (2, 15%) • Interesting package (2, 15%) *Negative* • Poor description / product confusion (4, 31%) • Expensive (2, 15%) • Small packaging (2, 15%)	*Positive* • Appetizing (2, 22%) • Healthy (2, 22%) • Interesting package (2, 22%) • New / different (1, 11%) *Negative* • Poor description / product confusion (2, 22%) • Expensive (2, 22%) • Small packaging (1, 11%)	*Positive* • Appetizing (1, 25%) • New / different (1, 25%) *Negative* • Poor description / product confusion (2, 50%) • Small packaging (1, 25%)
Awareness (*Promotion)*			• Increased new product awareness (2, 50%) • Low placement (1, 25%)
Attitude (*Promotion*)			• *Positive*: Visual appeal (1, 25%) • *Negative*: Unclear description (1, 25%)
Importance of Healthy Eating	• High (6, 46%) • Moderate (4, 31%) • Low (3, 23%)	• High (5, 55%) • Moderate (2, 22%) • Low (2, 22%)	• High (2, 50%) • Moderate (1, 25%) • Low (1, 25%)

E. CHAPTER IV

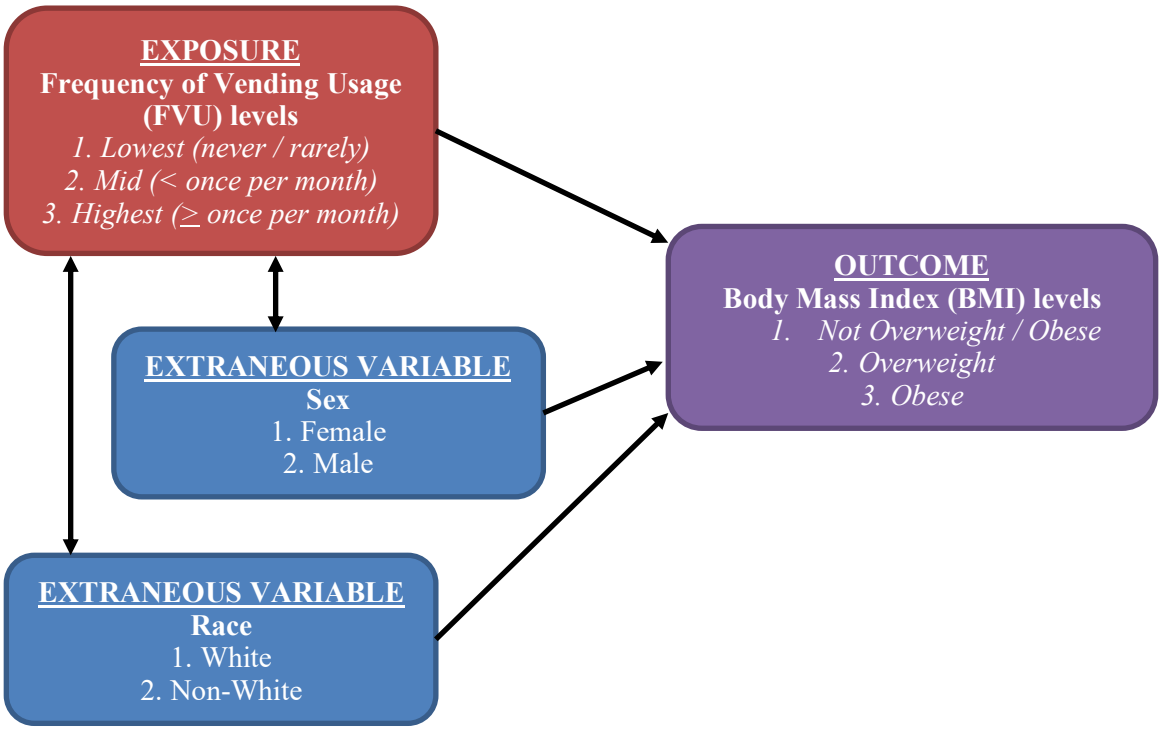


Figure E.1. Conceptual Model Representing Predictors of Weight Status Among College Students.

Table E.1. Description and Comparison of Demographic Characteristics of College Student Participants Overall, by Frequency of Vending Usage (FVU) Levels and by Body Mass Index (BMI) Levels.

	TOTAL	**Frequency of Vending Usage (FVU)**				**Body Mass Index (BMI)**			
	(n=110)	Lowest (n=54)	Mid (n=24)	Highest (n=32)		Not Over-weight / Obese (n=69)	Over-weight (n=29)	Obese (*n*=12)	
	Median [IQR]	*Median [IQR]*			*p*[a]	*Median [IQR]*			*p*[a]
Age (years)	18.0 [18, 19]	18.5 [18,19]	18 [18,19]	18 [18,19]	*.737*	19 [18,19]	18 [18,19]	18 [18,19]	*.228*
	n (%)	*n (%)*			*p*[b]	*n (%)*			*p*[b]
Sex					*.192*				*.931*
Male	20	7 (35)	4 (20)	9 (45)		12 (60)	6 (30)	2 (10)	
Female	90	47 (52)	20 (22)	23 (26)		57 (63%)	23 (26)	10 (11)	
Race					*.597*[c]				*.265*[c]
White	89	45 (51)	20 (23)	24 (27)		59 (66)	21 (24)	9 (10)	
Black	11	4 (36)	2 (18)	5 (46)		2 (18)	6 (55)	3 (27)	
Hispanic	7	2 (29)	2 (29)	3 (43)		6 (86)	1 (33)	0	
Other	3	3 (100)	0	0		2 (67)	1 (33)	0	
Academic Class					*.894*[d]				*.223*[d]
Freshman	76	38 (50)	17 (22)	21 (28)		46 (61)	19 (25)	11 (14)	
Sophomore	23	9 (39)	5 (22)	9 (39)		15 (65)	8 (35)	0	
Junior	8	6 (75)	1 (13)	1 (13)		5 (63)	2 (25)	1 (12)	
Senior	2	1 (33)	0	1 (33)		2 (100)	0	0	
Graduate	1	0	1 (33)	0		1 (100)	0	0	

* significant at $p < 0.05$

[a]Kruskal-Wallis test used due to non-normal distribution with continuous variables

[b]Fisher's exact test used due to cell counts less than 5 in at least one cell.

[c] Race combined into "white" and "non-white" (black, Hispanic, and other) variables for fisher's exact test.

[d] Academic class combined into "freshman" and "upperclassman" (sophomore, junior, senior, graduate student) for analysis.

Table E.2. Description and Comparison of Body Mass Index (BMI) by Frequency of Vending Usage (FVU) Levels Among College Student Participants (*n* = 108).

	Frequency of Vending Usage (FVU)			
	Lowest (n=54)	Mid (n=24)	Highest (n=32)	
	Median [IQR]			*p* [a]
BMI (kg/m^2)	22.7 [20.5, 25.2]	22.7 [21.5, 26.2]	25.8 [22.2, 30.0]	*.007**
	n (%)			*p* [b]
BMI Level				*.012**
Not Overweight/Obese	39 (57%)	17 (25%)	13 (19%)	
Overweight	13 (45%)	5 (17%)	11 (38%)	
Obese	2 (17%)	2 (17%)	8 (67%)	

Note: Lowest FVU = never; Mid FVU = < 1 time per month; Highest FVU = 1 time per month or more
[a]Kruskal-Wallis test used due to non-normal distribution with continuous variables
[b]Fisher's exact test used due to cell counts less than 5 in at least one cell.
*Significant at $p < .05$

Table E.3. Proportional Odds Logistic Regression Models for FVU Levels Predicting BMI Levels (*n* = 108).

Predictor	*OR*	*95% CI*	*p-values*
Mid FVU	1.23	.43, 3.59	.693
Highest FVU	4.46	1.78, 11.18	.001*

Note: Mid FVU = < 1 time per month; Highest FVU = 1 time per month or more
*Significant at $p < .05$

F. CHAPTER V

Table F.1. Demographic Characteristics of Participants Overall and by Group.

	Overall (*n*=71)	**Non-Vending Group** (*n*=35)	**Vending Group** (*n*=36)	**Mann Whitney-U Test**
	Median [IQR]	*Median [IQR]*		*p-value*
Age	19.0 [18, 19]	19.0 [18, 19]	19.0 [18, 19]	.77
BMI (kg/m²)	22.8 [20.7, 26.6]	21.9 [20.2, 25.1]	24.4 [21.5, 29.3]	.04*
CEPS-Vending [a]	3 [2, 4]	3 [2.5, 4]	2 [1, 4]	.04*
Bean Environment [b]	2 [0, 2]	2 [2, 2]	2 [0, 2]	.04*
Bean Consumption [c]	69 [48, 80]	67 [41, 78]	76 [18, 46]	.12
				Chi-Squared Test
	n (%)	*n (%)*		*p-value*
Gender				.35
Male	11 (16%)	4 (11%)	7 (19%)	
Female	60 (85%)	31 (89%)	29 (81%)	
Race [d]				.95
White/	55 (78%)	27 (77%)	28 (78%)	
Non-White	16 (22%)	8 (22%)	8 (22%)	
Academic Classification [e]				.11
Freshman	44 (62%)	25 (71%)	19 (53%)	
Upperclassman	27 (38%)	10 (29%)	17 (48%)	
Academic Major [f]				.54
Health	18 (25%)	10 (29%)	8 (22%)	
Non-Health	53 (75%)	25 (71%)	28 (78%)	
Diet [g]				.74 [i]
Omnivore	62 (87%)	30 (86%)	32 (89%)	
Plant-Based	9 (13%)	5 (14%)	4 (11%)	
BMI Category [h]				.04*
Not Overweight / Obese	44 (63%)	26 (65%)	18 (50%)	
Overweight / Obese	27 (38%)	9 (26%)	18 (50%)	
Frequency of Vending Usage				
Less than once a month			16 (44%)	
Once a month			5 (14%)	
Twice per month			9 (25%)	
1-3 times per week			6 (17%)	

[a] Possible score ranges from 0 to 8 points; *n*=69 overall and *n*=33 in the non-vending group due to two participant missing responses for one or both of the questions for this measure
[b] Possible score ranges from 0 to 4 points
[c] Possible score ranges from 0 to 117 points
[d] Race recoded as "white" and "non-white" (black, Hispanic, other) variables for analysis
[e] Academic class recoded as "freshman" and "upperclassman" (sophomore, junior, senior, graduate) for analysis
[f] Academic major recoded as "health major" (education, health, & human sciences; nursing; social work) and "non-health major" (agricultural science / natural resources; arts and sciences; business; engineering) for analysis
[g] Diet recoded as "omnivore" and "plant-based" (vegan, vegetarian, pescatarian) for data analysis
[h] BMI recoded as "not overweight/obese" (underweight, normal) and "overweight/obese" (overweight, obese) for analysis
[i] Fisher's exact test used due to expected cell count of less than 5 in at least one cell
* Significant at alpha < 0.05.

Table F.2. Pre- and Post-Intervention Survey Results for Primary Outcome Measures Overall and By Group.

	Overall (*n*=71)			**Non-Vending Group** (*n*=35)			**Vending Group** (*n*=36)		
	Pre M (SD)	*Post* M (SD)	*p-value*[a]	*Pre* M (SD)	*Post* M (SD)	*p-value*[a]	*Pre* M (SD)	*Post* M (SD)	*p-value*[a]
CEPS-Vending[b]	2.72 (1.49)	3.03 (1.52)	.143	3.06 (1.32)	3.00 (1.54)	.713	2.42 (1.59)	3.03 (1.54)	.034*
Bean Environment[c]	1.44 (.98)	1.25 (1.09)	.122	1.69 (.87)	1.54 (1.07)	.380	1.19 (1.04)	.97 (1.06)	.194
Bean Consumption[d]	65.62 (20.20)	68.13 (22.06)	.233	62.11 (22.05)	66.23 (24.22)	.129	69.03 (17.87)	69.97 (19.91)	.844

*significant at p<0.05

[a] Wilcoxon's matched pairs signed rank's test was used due to non-normally distributed continuous data.

[b] Possible score ranges from 0 to 8 points

[c] Possible score ranges from 0 to 4 points

[d] Possible score ranges from 0 to 117 points

Table F.3. Multiple Linear Regression Models with Primary Outcome Variables, Group, and Significant Independent Predictor Variables.

	B	Std. Error	Sig.	95% CI	R^2	Adj. R^2	F	p-value
CEPS-Vending								
Constant	-.252	.271	.356	-.794, .289	.122	.095	4.574	.014*
Vending Group	.723	.359	.048*	.006, 1.440				
Plant-Based Diet	1.264	.533	.021*	.201, 2.328				
Bean Environment								
Constant	-.143	-.755	.453	-.520, .235	.001	-.013	.089	.766
Vending Group	-.079	-.299	.766	-.610, .451				
Bean Consumption								
Constant	6.410	3.055	.040	.314, 12.506	.069	.041	2.509	.089
Vending Group	-3.234	4.005	.422	-11.225, 4.758				
Non-White Race	-10.043	4.792	.040*	-19.606, -.480				

G. CONCLUSION

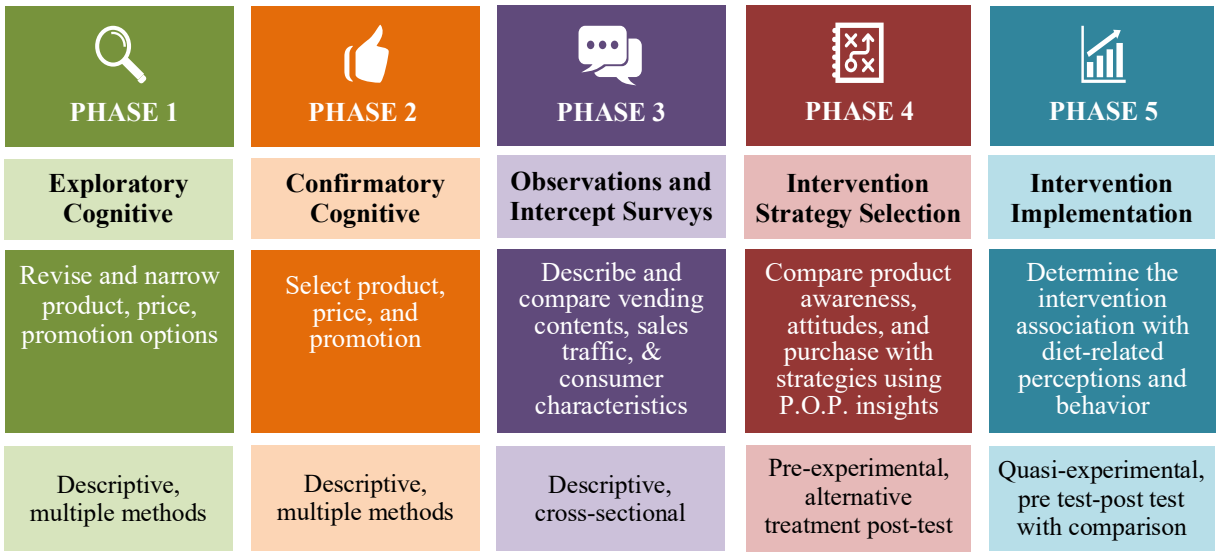


Figure G.1. Description of the Five Sequential Project Phases

VITA

Morgan Faulk Sowers was born in Lafayette, Louisiana to Ryan and Joell Faulk. Before attending the University of Tennessee, Knoxville, she earned her Bachelor of Science degree in Nutritional Sciences and Dietetics from Louisiana State University in Baton Rouge, Louisiana. She then completed a dietetic internship and supervised practice program to become a registered dietitian and also earned a Master of Science degree in Nutrition and Food Systems from the University of Southern Mississippi in Hattiesburg, Mississippi, where she was awarded the Outstanding Dietetic Intern and Outstanding Master's Student awards for her class. She then went on to earn a Master of Business Administration degree concentrating in marketing from the University of Tennessee, Knoxville. During her time as an MBA student, she acted as Vice President of Communications for the Tennessee Organization of MBAs (TOMBA) and also participated on the University of Tennessee's case competition team, which was awarded 1st and 2nd place in MBA business case competitions at the international and national level, respectively. After graduation with her Doctor of Philosophy degree, she plans to move to Chicago, Illinois where she has accepted a position with PepsiCo as part of their Nutrition Science Research and Development team.