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ASSOCIATIONS OF WEIGHT DISSATISFACTION ON
DIET QUALITY, PERCENT BODY FAT, AND PHYSICAL
ACTIVITY IN COLLEGE STUDENTS

BY

KELSEY MCNULTY

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE
IN
NUTRITION AND FOOD SCIENCES

UNIVERSITY OF RHODE ISLAND

2020

MASTER OF SCIENCE THESIS

OF

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2020

ABSTRACT

Statement of the Problem: As overweight and obesity rates continue to rise in the United States (U.S.), the social pressure to fit an impractical ideal body weight and image influences the satisfaction college-aged students have of themselves and can lead to higher body weight dissatisfaction (BWD). An increase in BWD has been associated with poorer dietary habits, such as lower intake of nutrient-dense foods like fruits and vegetables, excessive or lacking physical activity, as well as higher body mass index (BMI) and higher percent body fat (%BF). Since BWD has been determined as a contributor to increased risk of disordered eating, and has been shown to lead to poorer dietary and physical habits, investigating BWD is an important contribution to the existing literature.

Objective: The primary objective was to examine the association between BWD and total 2015 Healthy Eating Index (HEI) score, which is a measure for assessing dietary quality (DQ) and alignment with the 2015-2020 Dietary guidelines for Americans, in college-aged students at a university in the eastern U.S. from Fall 2015 to Fall 2019. The secondary objective was to determine the association between BWD and %BF utilizing the InBody 770 or BodPod. The tertiary objective was to evaluate the association between BWD and minutes of weekly moderate-to-vigorous physical activity. Exploratory objectives were to consider associations between BWD and dietary HEI components.

Methods: This cross-sectional, secondary data analysis was part of the Nutrition Assessment Study, an ongoing study that was created to examine the relationship between diet and disease risk in college students in an Applied General Nutrition

course at The University of Rhode Island. Undergraduate students (n=434, 78.6% females, 83.8% Caucasian, age=18.9 years) were stratified by sex for complete analyses. Students completed the Nutrition Assessment Survey for demographics and desired body weight. Absolute value of BWD was calculated by the difference between measured body weight and reported desired weight. Dietary data were collected through The Diet History Questionnaire II (DHQ II). The DHQ II was used to gather dietary intake and calculate component and total scores through the 2015 Healthy Eating Index (2015 HEI). Anthropometric measurements were taken via the InBody or Bod Pod to assess %BF. The International Physical Activity Questionnaire (IPAQ) short form was used to assess weekly physical activity. For all hypotheses, median split was used to group the independent variable, BWD, into higher and lower BWD groups. Outcomes were examined via independent t-tests and one-way ANOVAs; analyses stratified by sex. Acceptance of significance was identified as $p < 0.05$.

Results: Males (n=93) and females (n=341) were predominantly Caucasian (76.3%, 85.3%) with a normal average BMI (24.4 kg/m^2 , 23.0 kg/m^2). No significant differences between lower and higher BWD were observed for mean BMI and %BF in males. However, significant differences were found for mean BMI in females ($p < .001$) with lower BWD ($21.5 \pm 2.9 \text{ kg/m}^2$) and higher BWD ($24.4 \pm 2.6 \text{ kg/m}^2$), and for %BF ($F=75.4$, $\eta_p^2=.185$, $p=.001$). Significant differences were observed for males in some 2015 HEI components: total vegetables ($t(85)=2.827$, $p=.006$), greens and beans ($t(85)=2.753$, $p=.007$), and seafood and plant proteins ($t(85)=2.209$, $p=.030$). However, no significant differences were observed for total HEI score (males and

females), and 2015 HEI components (females). No significant between group differences were observed for minutes of weekly moderate-to-vigorous physical activity for males or females.

ACKNOWLEDGMENTS

There are many thanks that must be made to those who have helped me throughout this process. I would like to recognize and thank Dr. Kathleen Melanson for her continuous support and encouragement. She has supported and cheered me on these past six years during my undergraduate and master's career at the University of Rhode Island. I hope to continue to grow our relationship as professionals, as I know it has grown stronger over the years during my time as her volunteer, undergraduate assistant, and research assistant. I would also like to thank my committee members, Dr. Geoffrey Greene and Dr. Furong Xu, for I would not be where I am today if it were not for your kindness and willingness to help. Many thanks to the statistical consultants and undergraduate research assistants from the Energy Balance Laboratory for dedicating much of their time to help me towards my goals. Lastly, I would like to recognize and thank my family, boyfriend, and close friends who have stood by my side these eight years of college. It has been a long road and they have seen me go through many wonderful and difficult times. But they always pushed me and encouraged me to make it to the end.

PREFACE

This thesis was written to comply with the University of Rhode Island graduate school Manuscript Thesis Format. This thesis includes one manuscript, “Associations of Weight Dissatisfaction on Diet Quality, Percent Body Fat & Physical Activity in College Students” by Kelsey McNulty, Kathleen Melanson, Geoffrey Greene, and Furong Xu. This manuscript is written to align with the publication requirements for the Journal of College Health.

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**Associations of Weight Dissatisfaction on Diet Quality, Percent Body Fat, &
Physical Activity in College Students**

Kelsey McNulty, Kathleen Melanson, Geoffrey Greene, Furong Xu

Manuscript prepared for submission to the Journal of College Health.

Manuscript Abstract

Objective: This study aims to explore the absolute value of BWD and the association it has with total 2015 Healthy Eating Index (HEI) score, percent body fat (%BF) measured by the Bod Pod or InBody 770, and minutes of weekly moderate-to-vigorous physical activity (MVPA) in college-aged students.

Methods: This cross-sectional, secondary data analysis was part of the Nutrition Assessment Study, an ongoing study that was created to examine relationships between diet and disease risk in college students in an Applied General Nutrition course at an eastern university in Rhode Island. Undergraduate students (n=434, 78.6% females, 83.8% Caucasian, age=18.9) were stratified by sex for complete analyses. Students completed the Nutrition Assessment Survey for demographics, including desired body weight. Absolute value of BWD was calculated by the difference between measured body weight and desired weight. A median split was used to determine lower and higher BWD. Males (n=93) and females (n=341) were predominantly Caucasian (76.3%, 85.3%) with a normal average BMI (24.4 kg/m², 23.0 kg/m²). Dietary data were collected through The Diet History Questionnaire II (DHQ II). The DHQ II was used to gather dietary intake and calculate component and total scores through the 2015 HEI. Anthropometric measurements were taken via the InBody or Bod Pod to assess %BF. The International Physical Activity Questionnaire (IPAQ) short form was used to assess weekly MVPA.

Results: No significant differences were observed for mean BMI and %BF between males with higher or lower BWD. However, significant differences were found for mean BMI (p<.001) between females with lower BWD (21.5±2.9 kg/m²) and higher

BWD ($24.4 \pm 2.6 \text{ kg/m}^2$), and for %BF ($F=75.4$, $\eta_p^2=.185$, $p<.001$). Significant between group differences were observed for males in 2015 HEI components for total vegetables ($t(85)=2.827$, $p=.006$), greens and beans ($t(85)=2.753$, $p=.007$), and seafood and plant proteins ($t(85)=2.209$, $p=.030$). However, no significant between group differences were observed for total HEI score in males or females with higher versus lower BWD, and no differences for 2015 HEI components in females. No significant between group differences were observed for minutes of weekly moderate-to-vigorous physical activity for males or females.

Conclusion: In college-aged students, three lower HEI adequacy components in males and higher %BF in females were associated with higher BWD. These findings indicate that males with higher BWD may benefit from improving dietary intake, whereas females with more %BF have higher BWD than those with less %BF. These findings assist in understanding certain health behaviors in college-aged students that will support the formulation of recommendations for this population.

Key Words: *Body Weight Dissatisfaction, HEI, Diet Quality, Percent Body Fat, Physical Activity*

Introduction

Obesity rates are increasing nationwide in all age groups, with 42.8% of the U.S. population reported with overweight or obesity in 2017-2018.¹⁻⁴ As overweight and obesity rate continues to rise in the U.S., the social pressure to fit an impractical ideal body weight and image influences the satisfaction college-aged students have of themselves and can lead to higher body weight dissatisfaction (BWD).⁵ The term BWD is defined as the absolute value of the difference between reported body weight in pounds and reported desired body weight, and has been shown to vary by sex, socioeconomic status, and race and ethnicity.⁵⁻¹⁶ Previous studies has found that higher BWD is associated with negative health behaviors in college-aged students related to diet, such as excessive dieting and lower intake of nutrient-dense foods such as whole grains, fruits, and vegetables.^{9,17} However, limited research has examined the association between BWD and overall dietary quality (DQ) of college-aged students, as measured by the 2015 Healthy Eating Index (2015 HEI), which aids in the evaluation and monitoring of particular dietary components to better understand dietary patterns in individuals.¹⁸

There is minimal research on the association between BWD and DQ. Previous research has found those with lower BWD tend to consume more fruits and vegetables, compared to those with higher BWD.^{7,17,19,20} However, the data were not evaluated through DQ indices that aim to evaluate the overall diet and assess dietary patterns of an individual.^{7,17,19,20} One study analyzed BWD and DQ separately in a group of female university students.²¹ The results indicated more than half of the sample (57.4%) had BWD, with a total DQ score of 38.5 ± 6.7 measured by the Diet

Quality Index.²¹ Although this study found independent results for BWD and DQ in females, this study did not compare BWD with DQ, and therefore does not address the associations between the absolute value of BWD and DQ.

Higher BWD has also been associated with body mass index (BMI) and percent body fat (%BF). Research consistently shows a positive relationship between BMI, %BF, and BWD; higher BMI value and %BF, higher BWD.^{10,22–24} In general, BWD is influenced by BMI with a majority of individuals with overweight or obesity presenting with higher BWD.⁷ However, males tend to be more satisfied with weight regardless of overweight status.⁷ Although this relationship exists, there are differences observed by sex. Females tend to express greater BWD than males with a greater desire for a lower body weight and overall thinness.^{7,10,11,13,14,19} Additionally, females of normal-weight status tend to express higher levels of BWD, regardless of normal BMI and %BF.^{8,23} In contrast, males tend to express higher BWD with a greater desire for higher body weight with an increase in muscularity.^{10,11} Much of the literature on the association of BWD to %BF has measured %BF through hydrostatic weighing or skinfold calipers.^{17,23} However minimal research has examined %BF through air displacement plethysmography (Bod Pod) or multi-frequency bioelectrical impedance analysis (InBody 770).

Lastly, higher BWD has been associated with excessive or avoidance of physical activity (PA). Those with lower BWD tend to participate in more regular PA with higher levels of walking/jogging per week and higher cardiorespiratory fitness compared to those with higher BWD.^{7,17,25,26} However, some literature suggests that more active individuals have higher BWD than inactive individuals, possibly due to

their desire to change weight status.¹⁹ Although literature has examined the association of BWD and PA, there is a lack of research in examining minutes of weekly moderate-to-vigorous physical activity (MVPA). Since these research gaps remain within the BWD literature, this current cross-sectional, secondary data analysis was conducted to examine the associations BWD has with certain health behaviors in the population of college-aged students. This research will aid in better understanding the needs of the population and will assist in the formulation of future recommendations.

The purpose of the current study is to observe associations between BWD and total 2015 HEI score. The primary hypothesis is that participants with a lower BWD will have a higher total HEI score than participants with a higher BWD (n=434). The secondary hypothesis is that participants with a lower BWD will have a lower %BF than participants with higher BWD. The tertiary hypothesis is that participants with a lower BWD will report more minutes of weekly MVPA than participants with higher BWD.

METHODS

Study Design

This is a cross-sectional, secondary data analysis using data from the Nutrition Assessment Study (NAS), an ongoing International Research Board approved study at the University of Rhode Island. This study aims to examine nutrition assessment data for research to increase the comprehension of relationships between diet and disease risk in college students in an Applied General Nutrition course (NFS 210). This study involves gathering anthropometrics, PA, dietary data, and blood values through assessments from semesters in Fall 2015 through Fall 2019 that are required as part of

their coursework. To participate, potential participants were required to meet the following criteria: aged 18-24 years old, and enrollment in NFS 210 lab and course. Four-hundred thirty-four consenting participants were utilized for data analyses.

Research Participants

A defined sample was utilized for data analyses from Fall 2015 to Fall 2019. Students were excluded if they were <18 or > 24 years of age, pregnant, or had reported energy intakes of <400 and >7,000 kcal/day. This age group was selected to be consistent with other research conducted in college student populations and due to the lack of literature that addresses this age group in particular for BWD.^{22,27-30}

Data Collection

All data collection for this study occurred during the course lab sessions throughout the semester (Lab 2, 7, 9, and 10). Protocol guidelines were in place for all assessments including anthropometrics, blood values and survey data within the NAS Manual. During the first lab session, students were provided with verbal and written information about the research study, which was described in detail in the informed consent form (Appendix C). The NAS survey, known as the demographics survey, was administered during lab 2 and completed within one lab session. The IPAQ short-form was also administered in lab 2 and was to be completed within one lab session, which took approximately 10 minutes for the students to complete. The Diet History Questionnaire II (DHQ II) was administered during two lab sessions. Part 1 of the DHQ II was completed during lab 9 and part two was completed by lab 10. The anthropometric measurements were completed during lab 7 and included height weight, BMI, waist and hip circumference, and %BF using the air displacement

plethysmography (Bod Pod) and multifrequency bioelectrical impedance analysis (InBody 770).³¹ Anthropometric measures were collected by a trained member of the study. Additional assessments include blood values collected in lab 5 using Alere Cholestech® LDX System.

Instruments

Demographic Data

The independent variable, body weight dissatisfaction (BWD), was evaluated by utilizing the NAS survey. The NAS survey is an electronic survey includes 26 questions varying in number of items per response with response formats including multiple choice, open-ended, and Likert scale. The overall NAS survey has not been validated but has been utilized in previous research as a tool to gather demographic data. This survey gathered pertinent information to help differentiate between the students' actual measured weight in lab 7 versus their reported desired body weight in lab 2 to categorize students as those lower or higher BWD. The question used for this differentiation was, "What would you like to weigh in pounds," with an open-ended response category. The NAS survey gathered pertinent information on demographics as potential covariates. These included multiple-choice questions on age, sex, race/ethnicity, current major, and year in school.

Dietary Quality Measures

The dietary intake was collected utilizing data from the DHQ II (Appendix F) and was defined as total HEI score utilizing the 2015 HEI. The DHQ II is the food frequency questionnaire (FFQ) that provides an estimation of total daily caloric intake and evaluated DQ by utilizing the 2015 HEI.^{32,33} The 2015 HEI is a DQ index that

measures the alignment with the 2015-2020 Dietary Guidelines for Americans (DGA). The DHQ II was designed and tested by the National Cancer Institute.³² The DHQ has been validated as a superior FFQ compared to the Block and Willett FFQs for estimating absolute intakes in participants 20-70 years of age.³⁴ The 2015 HEI score was derived from the DHQ II, an FFQ that includes questions on 134 food items and eight dietary supplements.³² The DHQ II questioned the participant about food items and portion sizes that were consumed within the past year.^{32,35} The 2015 HEI is an index ranging from zero to one-hundred, which is based on thirteen individual components with scores per item from zero to ten with nine adequacy components: total fruits, whole fruits, total vegetables, greens and beans, whole grains, milk/dairy, total protein foods, seafood and plant proteins, and fatty acids. It also includes four moderation components: refined grains, sodium, added sugars, and saturated fat.³³ See Appendix I for 2015 HEI scoring guide. The 2015 HEI is updated every five years to reflect current federal dietary advice through a collaboration between the National Cancer Institute, and the US Department of Agriculture Center for Nutrition Policy and Promotion.³³ The output scores were calculated through the HEI-2015 algorithm within SAS software (SAS Institute Inc. version 9.4).

Anthropometric Measures

All measures for anthropometrics were taken according to standardized procedures.³⁶ Height was assessed using a wall-mounted stadiometer (SECA 240, Hamburg, Germany) and rounded to 0.1 cm, and weight was assessed using a digital scale (SECA 700, Hamburg, Germany) and rounded to 0.1 kg.³⁶ BMI, calculated as kilograms per meter squared (kg/m^2), was calculated using height and weight. Air

displacement plethysmography (Bod Pod) was utilized for semesters Fall 2015-Fall 2017 and multifrequency bioelectrical impedance analysis (InBody 770) for semesters Fall 2018-Fall 2019 to assess percent body fat (%BF). The Bod Pod (Life Measurement Inc. Concord, CA) estimates body density through air displacement plethysmography.³⁷ This device indirectly measures the volume of air displaced inside the chamber, “subtracting the volume of air remaining inside the chamber when the subject is inside to the volume of air when the chamber is empty.”³⁷ The InBody 770 is a multi-frequency bioelectrical impedance analysis device that measures the body’s resistance to flow of alternating electrical current at a designated frequency.³¹ It has been found that the Bod Pod and InBody 770 are valid and reliable measures of body composition in relation to DEXA and to each other.^{31,38,39}

Physical Activity Assessment: IPAQ Short-Form

PA was assessed using the IPAQ. The IPAQ is an electronic, seven item self-report instrument with response format of open-ended questions.⁴⁰ The IPAQ is a self-administered instrument that requires participants to report the frequency and duration of vigorous, moderate, and walking activities (10 minutes at minimum during the last seven days).⁴⁰ Weekly time spent in vigorous activity, moderate activity, and walking was determined by multiplying reported frequency and duration within each category of activity. This variable was calculated as minutes of weekly MVPA.⁴⁰

Statistical Analysis

The statistical analysis package SPSS (IBM version 26.0 SPSS Inc.) was used to perform statistical analyses. Skewness and kurtosis revealed data were non-normal when outliers were included. Outliers greater than three standard deviations from the

mean were identified and excluded for this reason.⁴¹ After exclusion of outliers, skewness and kurtosis were within normal ranges. A median split of BWD was used to categorize the independent variable into lower and higher BWD for the whole sample. Likewise, the median split was also stratified by sex. To assess between group differences, independent t-tests were conducted for demographic data for the whole sample and stratified by sex. To assess statistical differences between lower and higher BWD, one-way analysis of variance (ANOVA) was conducted for the following main outcomes: mean total HEI score, %BF, and minutes of weekly MVPA. One-way ANOVAs were run to determine effect size and post-hoc power analysis for the main outcomes. Effect sizes are defined as small (0.01), medium (0.06), and large (0.14).⁴¹ An additional one-way ANCOVA was run adjusting for energy for the primary objective. Both Bod Pod and InBody 770 are utilized similarly for their measurement of %BF, however, differ in methodology. For this reason, the two systems were combined for analysis and showed no statistically significant difference between the two systems ($p=0.75$). Likewise, previous literature are consistent with this finding showing relative agreement between Bod Pod and InBody, differing by less than 0.2%.³⁹ For these reasons, the two measurements were combined for the analysis of %BF. Pearson correlations were run with absolute value of BWD for 1) total HEI and component scores, 2) dietary components including total fat and dietary fiber in grams, 3) %BF and BMI. Additional Pearson correlations were run between %BF and BMI. Acceptance of significance was identified as $p<0.05$.

RESULTS

Subject Characteristics

Of the consenting participants (n=671), 237 were excluded based on the following criteria: non-consented students (n=170), age <18 (n=4), age >24 (n=30), intake <400 kilocalories (n=5), intake >7,000 kilocalories (n=3), missing data (n=172), and participation in multiple semesters (n=9). In addition, subjects were defined as outliers if BWD was greater than three standard deviations from the mean and these subjects were also excluded (n=14).⁴¹ Four-hundred thirty-four participants were retained for the final sample. It is important to note that final sample size for the tertiary variable (n=307) minutes of weekly MVPA differs from primary and secondary sample sizes due to exclusion of participants with missing data from IPAQ (n=127). See Figure 1 for the flowchart on recruitment and retention of participants.

Mean subject characteristics for the whole sample are presented in Table 1. Participants, aged 18-24, were assigned to lower BWD (n=217) or higher BWD (n=217) by median split. As shown in Table 1, participants were predominantly female (78.6%), Caucasian (83.8%), within their first year of college (60%), and with a mean age of 18.9 years. BMI for both lower BWD ($21.9 \pm 3.2 \text{ kg/m}^2$) and higher BWD ($24.6 \pm 3.1 \text{ kg/m}^2$) were within the normal range. Independent t-tests revealed significant differences between groups of lower and higher BWD for BMI ($p=.001$) and sex ($p=.047$) in the whole sample.

All models were conducted for the whole sample without stratification, and stratified by sex. Final results are presented as stratified by sex, and were analyzed through one-way ANOVAs. See Appendix J for additional results on whole sample

data. As shown in Table 2, males (n=93) and females (n=341) were assigned to lower BWD and higher BWD by median split. See Table 5 in Appendix J for median split criteria by whole sample and sex. Males had a mean age of 19 years, were predominantly Caucasian (76.3%) with a normal average BMI (24.4 kg/m^2). Females had a mean age of 18 years, were predominantly Caucasian (85.3%), with a normal average BMI (23.0 kg/m^2). Independent t-tests revealed no significant differences in BMI between lower and higher BWD in males. Significant differences were found in BMI between females with lower and higher BWD ($p=.001$), with lower BMI ($21.5 \pm 2.9 \text{ kg/m}^2$) in the lower BWD compared to higher BMI ($24.4 \pm 2.6 \text{ kg/m}^2$) present in the higher BWD group.

Total 2015 HEI score

A one-way ANOVA was conducted to determine if participants with a lower BWD have a higher total HEI score than participants with a higher BWD. As shown in Table 3, when stratified by sex, the hypothesis was not supported. The one-way ANOVA demonstrates a trend towards significance in males with small to moderate effect size for total HEI score ($F=3.223$, $\eta_p^2=.037$, $p=.076$), suggesting a slightly higher total HEI score in male participants with lower BWD (64.3 ± 10.3) compared to those males with higher BWD (60.2 ± 10.8). There were no significant between group differences for total HEI score for females ($F=0.161$, $\eta_p^2=.001$, $p=.689$). Even after adjusting for caloric intake, there was no statistical difference in males ($p=0.088$) or females ($p=0.654$).

2015 HEI Components

Independent t-tests were run for all 2015 HEI adequacy and moderation components: total fruits, whole fruits, total vegetables, greens and beans, whole grains, total dairy, total protein, seafood and plant proteins, fatty acids, refined grains, added sugars, saturated fats, and sodium. In Table 4, results demonstrate significant between group differences for 2015 HEI components in males. Significance was yielded in adequacy components for total vegetables ($t(85)=2.827$, $p=.006$), greens and beans ($t(85)=2.753$, $p=.007$), and seafood and plant proteins ($t(85)=2.209$, $p=.030$) in males. The results indicate males with lower BWD have a higher intake of total vegetables, greens and beans, and seafood and plant proteins compared to those with higher BWD. No between-group differences were shown for 2015 HEI components in females. Although results for adequacy components were significant in males, there is a chance of Type 1 error due to multiple comparisons increasing the likelihood of spurious results.⁴²

Percent Body Fat

In Table 3, the hypothesis that participants with a lower BWD will have a lower %BF than participants with a higher BWD was supported for females. A one-way ANOVA demonstrates no statistical significance for between group differences in %BF for males ($F=.000$, $\eta_p^2=.000$, $p=.988$). There were between group differences in females ($F=75.380$, $\eta_p^2=.185$, $p=.001$); females with lower BWD have a lower %BF ($24.8\pm5.8\%$) compared to females with a higher BWD (30.3 ± 5.8). Pearson correlations detected a significant, moderate correlation between %BF and BMI ($p=.001$, $r^2=.418$) measured by BodPod or InBody 770. A one-way MANOVA reveals

that there were no between subject effects in males for %BF ($p=0.809$) and total HEI score ($p=0.137$). However, the one-way MANOVA does reveal significant between subject effects in females for %BF ($p=0.001$), however no difference is revealed for total HEI score ($p=0.744$).

Minutes of Weekly Moderate-to-Vigorous Physical Activity

Within Table 3, a one-way ANOVA found no significant between group differences for minutes of weekly MVPA for males ($F=.242$, $\eta_p^2=.003$, $p=.625$) or females ($F=.453$, $\eta_p^2=.002$, $p=.501$). The hypothesis that participants with a lower BWD will report more minutes of weekly MVPA on the IPAQ than participants with higher BWD was not supported.

Discussion

This study demonstrated that higher BWD in males is associated with lower HEI adequacy components (greens and beans, total vegetables, seafood and plant proteins), whereas higher BWD in females is associated with higher %BF. The primary objective of this cross-sectional, secondary data analysis was to examine the association between BWD and total 2015 Healthy Eating Index (HEI) score. The secondary objective was to determine the association between BWD and %BF utilizing the InBody 770 or BodPod. The tertiary objective was to evaluate the association between BWD and minutes of weekly MVPA. in college-aged students. BWD, the absolute value of the difference between reported body weight in pounds and reported desired body weight, was defined using a median split of to categorize the independent variable into lower and higher BWD.⁵⁻¹⁶ Additionally, the median split was stratified by sex due to differences commonly seen by sex. Generally, the results for the primary and tertiary variables indicate BWD in males and females are

not associated with total HEI score and minutes of weekly MVPA. However, the secondary variable, %BF, does support previous findings suggesting that those females with lower BWD will have a lower %BF compared to those with higher BWD. However, these findings are not seen in males.

This is the first study to examine the association of absolute value of BWD as higher and lower values and total 2015 HEI score. We found no association between BWD and total HEI score in males or females. Although not statistically significant, males were trending towards significance with a small to moderate effect size and moderate power indicating that significant results may be possible with a moderate sample size. Females showed no statistical significance with small effect size and low power suggesting that even with a larger sample size there would still be no significant difference between groups. While the primary hypothesis has been rejected, the overall total HEI score in males (64.3 ± 10.3 and 60.2 ± 10.8) and females (65.4 ± 10.9 and 64.9 ± 11.2) is consistent with scores obtained by previous literature. Similar results were found in a cross-sectional survey of college students,⁴³ with diet intake gathered by the DHQ I and evaluated by 2015 HEI. Unlike Reedy et al.³³ and Amaral et al.,²¹ the present study shows a higher total HEI score for college-aged students than what has been previously found. One reason the total 2015 HEI score may be elevated compared to previous literature is because the respondents were enrolled in a nutrition course with a lab session. This could have increased the respondents' interest in what was being consumed. Likewise, a majority of respondents are health science or nutrition/dietetics majors. For this reason, these respondents are possibly more aware of their total caloric intake and therefore have a higher total HEI score.

BWD was found to be associated with adequacy components from the 2015 HEI among males in the present study, which is inconsistent with previous findings from Sunbul et al.⁴³ who found that males tend to have higher 2015 HEI component scores of total protein, while females have higher component scores of total fruits, total vegetables, whole grains, and greens and beans.⁴³ Likewise, Guenther et al.,⁴⁴ also found higher 2010 HEI component scores intake in females versus males in total vegetables (3.7 ± 0.1 vs. 3.3 ± 0.1), greens and beans (2.2 ± 0.1 vs 1.8 ± 0.1), whole fruits (2.9 ± 0.1 vs 2.3 ± 0.1), and total fruits (2.8 ± 0.1 vs 2.2 ± 0.1) respectively. However, one study⁴⁵ found low scores in vegetables (3.6 ± 1.2), whole grains (4.6 ± 2.3), and fatty acid ratio (4.6 ± 2.8) in females. That study only analyzed female participants, therefore a comparison with HEI components in males was unattainable. A possible reason for significance in three adequacy components for males could be the higher caloric intake. However, even after adjusting for energy for total 2015 HEI score, there was no statistical significance between BWD groups in males ($p=0.088$) or females ($p=0.654$). See Table 11 for results on BWD and dietary HEI components. Although results for adequacy components were significant in males, there is a chance of Type 1 error due to multiple comparisons.⁴² The significance level of 5% for alpha is set for single comparisons between groups. However, since the groups were compared multiple times, the probability of finding significance increases the possibility of spurious results.⁴²

The results obtained for BWD and %BF in the present study suggest that females with lower BWD have lower %BF compared to those with higher BWD. However, no association is shown in males for BWD and %BF given that the mean

values were identical for both lower and higher BWD at 17.1 ± 7.7 and 17.1 ± 10.1 respectively. This suggests that the males with lower or higher BWD did not vary by %BF. It is important to note that %BF in males has a small effect size suggesting that even with a larger sample size, no significant would be obtained. The findings for females are similar to findings from Arroyo et al.,²³ who examined the predictors of the magnitude of BWD in undergraduate females and found that higher levels of %BF were associated with greater BWD. The relationship found in this study between BWD and BMI is consistent to that of previous literature. Females with lower BWD had lower BMI compared to those with higher BWD, whereas males with lower or higher BWD had the same BMI values indicating normal-weight status. These findings are similar to that of previous studies where those of overweight status expressed higher BWD compared to underweight and normal-weight counterparts.^{10,14}

Although relationships between BWD and weekly physical activity time were not statistically significant in the present study, the findings may still be of importance for future evaluation. Males who have lower BWD appeared to partake in more minutes of weekly MVPA compared to those with higher BWD, whereas females with lower BWD appeared to partake in less minutes of MVPA compared to those with higher BWD. These results are similar to one study,⁴⁶ however contrast with the previous literature by Blake et al.,⁷ a cross-sectional study with a large mixed gender cohort of adults ($n=19,003$) where physical activity was assessed through a leisure-time physical activity questionnaire and separated into three categories: Inactive (no regular activity), moderate (some participation in activity like walking, jogging, running 10 miles per week), and active (walking, jogging, or running more than 10

miles per week).⁷ Weight satisfaction was associated with higher engagement in physical activity, whereas weight dissatisfaction was associated with lower physical activity.⁷ The contrasting results in females is not consistent with a majority of the literature, however one article¹⁹ presents similar results. In a large population-based study (n=18,156) of Swiss adults, PA was assessed by asking participants, “In your free time, do you exercise until you sweat, at least once per week?”¹⁹ They were split into three categories: active, partly active, and inactive.¹⁹ Results showed that more active individuals report higher BWD than inactive individuals, possibly due to their desire to change weight status.¹⁹ These results indicate that females with higher BWD may desire to change weight status, and therefore have higher minutes of weekly MVPA. It is important to note that the insignificant results could be due to over-reporting on the IPAQ, which is common in self-reported physical activity compared to objectively measured physical activity.⁴⁷ Although there is no significance in MVPA, the mean values can lead to a better understanding of activity behavior in the college-aged population. Overall, males present with higher minutes of weekly MVPA compared to females, which is consistent with findings from previous literature.^{40,46,48–50} Although the sample includes both lower and higher BWD, on average, both males and females are meeting and exceeding the *2018 Physical Activity Guidelines* for MVPA.⁴⁸

While this study does make contributions to the existing literature for BWD, some limitations should be addressed. First, causation is not able to be inferred due to the cross-sectional design. Second, there is a lack of generalizability since the majority of the sample was 18-19 years of age, female (n=341), and Caucasian. Likewise, the

sample gathered is a limitation since the majority of consented students were female and from a nutrition course with a lab session at a university campus, which presents a very select sample and not representative of the university population. Therefore, we are unable to generalize it to other university students, nor other age groups or populations. Additionally, BWD was measured indirectly within the current study through measured body weight and self-reported desired body weight. For this reason, we are only able to assume dissatisfaction based on a quantitative measure, rather than qualitative where the participant is questioned about their satisfaction.^{5,7,14,19} Although this is a limitation, it is still an acceptable measure for absolute value of BWD and has been utilized in previous studies.^{8,10,23,51} Moreover, when gathering BWD, the time difference upon gathering desired body weight and actual body weight increases probability of error. The desired body weight was recorded in lab 2, whereas the participants actual weight was recorded six weeks later in lab 7. For this reason, the participants may have been unaware of actual body weight, and may complete the survey response with an inaccurate reported desired body weight. Furthermore, the use of two different methods for %BF measures increase risk of error. The Bod Pod is considered air displacement, whereas InBody 770 is bioelectrical impedance. Although previous literature states relative agreement between the two methods, there is still a chance of error but differs by less than 0.2%.³⁹ Additionally, self-report response bias, or social desirability bias, may lead to skewed results.⁵² Lastly, incomplete data for IPAQ measurements decreases the overall sample size for MVPA, and thus the power of the analysis.

While there are limitations, this study does contain significant strengths. This is the first study to analyze BWD and the associations it has with dietary quality measured by the 2015 HEI as total HEI score. Prior literature collected dietary quality (DQ), but did not present an association with BWD, nor did they utilize the 2015 HEI to assess adherence with the 2015-2020 DGA. Additionally, this is the first study to analyze associations between BWD and %BF measured through air displacement plethysmography and multifrequency bioelectrical impedance analysis, which is a newly developed instrument. Previous literature assessed body image and BWD, however, analyzed %BF through skinfold calipers, which is a less accurate measurement. Further, this study utilizes multiple surveys and tools that have been validated, such as: DHQ II, 2015 HEI, IPAQ short-form, Bod Pod, and InBody 770. Lastly, the sample size within this cross-sectional analysis is large compared to other studies that have analyzed BWD in college-aged students.

Future Implications and Conclusions

While the current study did not yield results for associations between BWD, and total HEI score and minutes of weekly MVPA, the results contribute to the existing literature on BWD by increasing our comprehension of health-related habits in college-aged students. Future research should analyze these variables to further increase our understanding of this university population. The focus should be on a more diverse population of varying majors on university campuses or in different settings, to better understand the habits of other college-aged students outside of the health field. Likewise, longitudinal studies should be conducted on BWD since there is minimal evidence exploring BWD over time. Additionally, total HEI and HEI

components should be explored further with a larger sample size for males, as well as in other majors and populations to gather a better understanding of adherence to guidelines. Furthermore, associations between BWD and %BF in females increases our comprehension of the higher BWD that is apparent in females, but not males. Females with lower BWD have lower %BF compared to those with higher BWD. These findings add to the current literature on absolute value of BWD and may assist in understanding certain health behaviors, such as dietary intake and body composition, in college-aged students that will support the formulation of recommendations for this population.

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Tables

Table 1. Mean Demographic Values by Group – Whole Sample			
Variable Mean ($\pm$ SD)	Lower BWD (n= 217)	Higher BWD (n= 217)	<i>p</i>
Age (years)	18.8 (1.2)	18.9 (1.3)	.302
BMI (kg/m ²)	21.9 (3.2)	24.6 (3.1)	.000**
Sex n (%)			
Male	38 (40.9)	55 (59.1)	.047*
Female	179 (52.5)	162 (47.5)	
Race/Ethnicity n (%) ¹			.369
Caucasian	184 (85.2)	178 (82.4)	
African American	4 (1.9)	5 (2.3)	
Hispanic/Latino	14 (6.5)	16 (7.4)	
Asian	6 (2.8)	5 (2.3)	
Mixed/Other ²	8 (3.7)	12 (5.6)	
School Year n (%)			.397
Freshman	138 (63.6)	124 (57.1)	
Sophomore	46 (21.2)	56 (25.8)	
Junior	23 (10.6)	30 (13.8)	
Senior	10 (4.6)	7 (3.2)	
<i>Abbreviations:</i> BWD- Body Weight Dissatisfaction, SD – standard deviation, BMI – Body Mass Index, kg/m ² – kilograms over meters squared; * <i>p</i> <0.05, ** <i>p</i> <0.01; Magnitude of Body Weight Dissatisfaction; Independent Samples T-Test ¹ Removed ‘Missing’ category from Race/Ethnicity data in table for those who did not fill out this question. ² Race/Ethnicity categories ‘Mixed’ and ‘Other’ combined to ‘Mixed/Other’ for descriptive analysis			

Table 2. Mean Demographic Values by Group – Stratified by Sex						
Variable Mean ($\pm$ SD)	Male (n= 93)		<i>p</i> ¹	Female (n= 341)		<i>p</i> ²
	LBWD (n= 47)	HBWD (n= 46)		LBWD (n= 171)	HBWD (n= 170)	
Age (years)	19.3 (1.6)	19.4 (1.3)	.596	18.8 (1.2)	18.9 (1.2)	.526
BMI (kg/m ²)	24.1 (3.7)	24.7 (4.1)	.431	21.5 (2.9)	24.4 (2.6)	.000**
Race/Ethnicity n (%)						
Caucasian	36 (39.1)	35 (38.0)	.698	147 (43.2)	144 (42.4)	.716
African American	1 (1.1)	1 (1.1)		3 (0.9)	4 (1.2)	
Hispanic/Latino	4 (4.3)	7 (7.6)		10 (2.9)	9 (2.6)	
Asian	1 (1.1)	1 (1.1)		5 (1.5)	4 (1.2)	
Mixed/Other ¹	4 (4.3)	2 (2.2)		6 (1.8)	8 (2.3)	
<i>Abbreviations:</i> SD – standard deviation, LBWD- Lower Body Weight Dissatisfaction, HBWD – Higher Body Weight Dissatisfaction. BMI – Body Mass Index, kg/m ² – kilograms over meters squared; * <i>p</i> <0.05, ** <i>p</i> <0.01; <i>p</i> ¹ – <i>p</i> -value for males, <i>p</i> ² – <i>p</i> -value for females; Magnitude of Body Weight Dissatisfaction; Independent Samples T-Test ¹ Race/Ethnicity categories ‘Mixed’ and ‘Other’ combined to ‘Mixed/Other’ for descriptive analysis						

Table 3. Descriptive Analysis of Main Outcomes – Stratified by Sex								
Strata	Variable	Group	N	Mean (±SD)	F	η _p ²	Observed Power	p
Male	HEI Total Score	Lower BWD	43	64.3 (10.3)	3.223	.037	.427	.076
		Higher BWD	44	60.2 (10.8)				
	BF (%)	Lower BWD	46	17.1 (7.7)	.000	.000	.050	.988
		Higher BWD	44	17.1 (10.1)				
	MVPA (min/wk)	Lower BWD	27	519.6 (308.9)	.242	.003	.077	.625
		Higher BWD	45	486.5 (256.5)				
Female	HEI Total Score	Lower BWD	154	65.4 (10.9)	.161	.001	.069	.689
		Higher BWD	154	64.9 (11.2)				
	BF (%)	Lower BWD	168	24.8 (5.8)	75.380	.185	1.000	.001**
		Higher BWD	167	30.3 (5.8)				
	MVPA (min/wk)	Lower BWD	127	301.8 (212.2)	.453	.002	.103	.501
		Higher BWD	108	321.4 (235.3)				
<i>Abbreviations:</i> BWD- Body Weight Dissatisfaction, HEI- Healthy Eating Index, BF- Body Fat, measured as percent by air displacement plethysmography and bioelectrical impedance analysis, MVPA- Moderate-to-Vigorous Physical Activity, min-minutes, wk- week; F value based on one-way ANOVA, *p<0.05, **p<0.01; Magnitude of Body Weight Dissatisfaction, Stratified by Sex; one-way Analysis of Variance (ANOVA)								

Table 4. Between Group Comparisons for 2015 HEI Components – Stratified by Sex					
Male					
Variable Mean (possible score)	Lower BWD Mean ($\pm$ SD) (n= 43)	Higher BWD Mean ($\pm$ SD) (n= 44)	<i>t</i>	df	<i>Pp</i>
Adequacy (60)					
Total Fruits (5)	3.7 (1.5)	3.4 (1.6)	.994	85	.323
Whole Fruits (5)	4.1 (1.4)	3.6 (1.7)	.1578	85	.119
Total Vegetables (5)	3.9 (1.4)	3.0 (1.5)	2.827	85	.006**
Greens and Beans (5)	4.1 (1.4)	3.1 (1.9)	2.753	85	.007**
Whole Grains (10)	2.1 (1.4)	2.0 (1.3)	.300	85	.765
Total Dairy (10)	5.7 (2.8)	6.2 (3.1)	-.903	85	.369
Total Protein (5)	4.3 (1.3)	3.9 (1.4)	1.285	85	.203
Seafood and Plant Protein (5)	4.1 (1.5)	3.3 (1.7)	2.209	85	.030*
Fatty Acids (10)	5.6 (3.2)	4.6 (3.3)	1.483	85	.142
Moderation (40)					
Refined Grains (10)	7.5 (2.9)	7.8 (2.7)	-.469	85	.640
Added Sugars (10)	7.4 (3.1)	6.9 (3.1)	.767	85	.445
Saturated Fats (10)	7.2 (2.7)	6.9 (2.7)	.593	85	.554
Sodium (10)	4.7 (3.0)	5.5 (3.2)	-1.316	85	.192
Female					
Variable Mean (possible score)	Lower BWD Mean ($\pm$ SD) (n= 154)	Higher BWD Mean ($\pm$ SD) (n= 154)	<i>t</i>	df	<i>P</i>
Adequacy (60)					
Total Fruits (5)	3.9 (1.5)	3.9 (1.4)	.704	306	.941
Whole Fruits (5)	4.3 (1.3)	4.2 (1.3)	.163	306	.871
Total Vegetables (5)	4.1 (1.1)	4.1 (1.2)	.128	306	.898
Greens and Beans (5)	4.1 (1.5)	4.1 (1.5)	.421	306	.674
Whole Grains (10)	2.5 (1.3)	2.3 (1.5)	1.113	306	.267
Total Dairy (10)	5.7 (2.7)	6.0 (2.7)	-.945	306	.345
Total Protein (5)	4.2 (1.1)	4.1 (1.3)	.888	306	.375
Seafood and Plant Protein (5)	4.2 (1.3)	4.0 (1.5)	1.373	306	.171
Fatty Acids (10)	5.6 (3.2)	5.5 (3.2)	.284	306	.777
Moderation (40)					
Refined Grains (10)	7.5 (2.7)	7.8 (2.6)	-1.192	306	.234
Added Sugars (10)	7.8 (2.5)	7.4 (2.9)	1.192	306	.234
Saturated Fats (10)	6.2 (2.8)	6.6 (3.0)	-1.271	306	.205
Sodium (10)	5.3 (2.5)	4.9 (2.8)	1.534	306	.126
Abbreviations: BWD- Body Weight Dissatisfaction, SD – standard deviation;					
*p<0.05, **p<0.01; Magnitude of Body Weight Dissatisfaction; Independent Samples T-Test, Stratified by Sex					

Figure 1: Flowchart for Participant Recruitment and Retention

APPENDIX A: Review of the Literature

Introduction

In 2015-2016, the average overweight and obesity rate within the United States (U.S.) was 40%, and increased to 42.8% in 2017-2018.¹⁻⁴ As overweight and obesity rates continue to rise, the social pressure to fit an impractical ideal body image and weight within the U.S. may influence the perception and satisfaction college-aged students have of themselves.⁵⁻⁷ This can translate into negative body image and higher body weight dissatisfaction (BWD), which has been identified as one of the several behavioral patterns associated with the development of eating disorders.⁸⁻¹⁰ BWD is defined as the difference between actual weight and desired ideal body weight, and has been shown to vary in degree by sex, socioeconomic status, and race and ethnicity.^{6,8,11-20} Detrimental behaviors that are commonly found within the research regarding BWD are: excessive dieting, lower dietary intake of nutrient-dense foods such as fruits and vegetables, worsening body composition, increased body mass index (BMI), and excessive or avoidance of physical activity (PA).^{1,2,6,8,11,14,21,22} Although BWD has been associated with these outcomes and health behaviors, inconsistencies remain within the previous literature. The following components and their associations with BWD have yet to be examined within the college-aged population: overall dietary quality (DQ) as measured by the 2015 Healthy Eating Index (HEI-2015), percent body fat (%BF) measured by the InBody 770 and Bod Pod, and minutes of weekly moderate-to-vigorous PA (MVPA) utilizing the newly revised *2018 Physical Activity Guidelines for Americans*. The purpose of this literature review is to explore in depth the associations BWD has with DQ, %BF, and PA in previous literature.

Body Weight Dissatisfaction

The term BWD is a quantitative measure of the discrepancy between an individual's actual weight and desired body weight, and can be interpreted as a desire to weigh more or to weigh less.^{8,14} BWD can be measured directly or indirectly through various methods including, but not limited to, absolute value, relative value, or as a polar question administered through survey or questionnaire.^{8,9,11,13,14,18,23–25} Although these methods measure the discrepancy of satisfaction in weight, they vary in methodology and interpretation of scores. The absolute value of BWD is an indirect measure that assesses the overall magnitude of weight discrepancy that is experienced by those who desire to weigh less or more. The score of zero indicates complete body weight satisfaction.^{8,9,14} The further the individual is away from the score of zero, the more dissatisfaction they contain. This method of measurement is the most common found within the literature. The relative value, or the direction of BWD, scores the satisfaction based on their desire to lose or gain weight; a positive score indicates the desire to lose weight and a negative score indicates the desire to gain weight.^{13,23} Lastly, a polar, or yes-no, question can be asked of the participant to directly measure if they are satisfied with their weight.^{11,18,24,25} Although a polar question of whether the individual is satisfied with their weight is a better indication of their actual satisfaction, this method limits the ability to assess the magnitude of satisfaction, and is therefore used commonly in conjunction with the absolute or relative value.

BWD is found within all age groups, sexes, weight statuses, and racial and ethnic groups. The degree of BWD is highly variable between groups, but remains consistent among various studies. For instance, females tend to express greater BWD

than males, with a greater desire for a lower body weight and overall thinness.^{10,13–15,17,18} In contrast, males tend to express higher BWD with a greater desire for higher body weight with an increase in muscularity.^{14,15} Within a quasi-experimental design, Neighbors and Sobal¹⁴ examined the magnitude of body weight and shape individuals idealize, the differences established among sexes, and how the dissatisfaction differs between sexes. The study sample was comprised of undergraduate students from science and human development courses (n=326) with a mean age of 20.0±1.4 years.¹⁴ A brief survey was administered that questioned the following aspects: demographics, body size characteristics, body size importance, and weight loss attempts. The participants were asked to self-report their current height and weight which was utilized to calculate BMI, as well as their “current ideal weight” in pounds (lbs.) to gather BWD in absolute value. The results indicated that normal-weight females desired a body weight that was approximately one BMI unit (approximately 7.2 lbs.) lower than their status, compared to normal-weight males who desired to gain approximately 0.4 BMI units (approximately 2.8 lbs.).¹⁴ Overall, when controlling for BMI, the desire to weigh less was much higher in females compared to males.¹⁴

Likewise, a 2012 cross-sectional study examined the sex differences in BWD and the prevalence of disordered eating based on data from a population-based survey.^{10,18} The study sample focused on Icelandic adults (n= 5,832), 18-79 years of age. Self-reported BWD was assessed through a multiple-choice question asking, “How satisfied or dissatisfied do you feel with your own body weight?” Responses were cross tabulated as such: dissatisfied with body weight, neither satisfied nor dissatisfied, and satisfied with body weight.¹⁸ Among females, 50.1% reported BWD

compared to 35.1% of males. Furthermore, 64% of females within the normal-weight category desired to lose weight compared to approximately 19% of normal-weight males.¹⁸ Overall, females demonstrate higher BWD compared to males.

Regardless of differences in BWD by sex, it is commonly known that BWD is highly influenced weight status as overweight or obese having higher BWD.^{8,9,13,26} In a cross-sectional study, Blake et al.¹³ examined a large mixed cohort (n=19,003) of white, middle-to-upper socioeconomic status adults between 1987 and 2002.¹³ Results indicated that men and women who presented with overweight or obese status had higher BWD than their counterparts with normal-weight status, with approximately 3% of overweight or obese females being satisfied compared to 27% of male participants with overweight or obesity. Similar results were obtained in different studies by Lori et al.¹⁴ and Ejike et al.²⁵ with approximately 48% and 99% of participants with overweight or obesity expressing higher BWD respectively. In general, BWD is influenced by BMI with a majority of participants of overweight or obese status presenting with higher BWD.

Although high BWD is seen in those with overweight or obese weight status, high BWD has also been observed in participants of normal-weight status.^{8,9,13} A study examined the extent and predictors of BWD in a sample of female volunteers in nutrition and dietetics majors who were of normal-weight status according to World Health Organization BMI range (n=62).⁹ To obtain the participants desired body weight, they were asked to respond to an open-ended question, “Ideally, how much would you like to weigh?” The discrepancy was assessed with measured weight and ideal weight to obtain an absolute value of BWD. Anthropometric measures were

taken such as height, weight, and fat mass using skinfold calipers. Of the female sample, 67.7% of participants chose an ideal body weight lower than their actual body weight, indicating more than half of the sample of normal-weight females expressed high BWD regardless of normal-weight status. This BWD was highly associated with lower levels of muscle mass. These results were similar to an experimental study conducted by Harris et al.⁸ who utilized similar methodology in female students majoring in nutrition and exercise science, and other majors not including nutrition and exercise science (n=89). Among all three groups measured, 83% of the participants expressed BWD with a desire to weigh less. Although 90% of the nutrition students were of normal BMI, 84% expressed a desire to weigh less than their actual weight. These results indicate that despite the participants' current major, "college students may experience pressures to weigh less and 'fit the image.'"⁸

While BWD has been examined in multiple age groups and populations, considerable emphasis is on the adolescent population.²⁷ This can be due in part to the participants' transition from adolescence to young adulthood, a time of drastic developmental change and independent living that influences their health-behaviors that are carried into the future.²⁸⁻³⁰ Although adolescent populations are a primary population of concern for adapting future health-behaviors, it has also been examined in young-adults and the adult population. Within these populations, BWD and body image have been identified as one of the behavioral patterns that are associated with eating disorders.⁹ For this reason, it has been examined along with weight perception to gain a better understanding of the extent of these concepts and their influence on

particular health-behaviors.⁹ While BWD, body image, and weight perception differ in definition, they are each associated with dietary and PA behaviors.²⁷

Body Image & Weight Perception

Body image is defined as an individual's "perceptions, feelings, and thoughts about his/her own body," whereas weight perception is the way the individual views their body weight with no regard to appearance.^{27,31,32} Although these concepts are defined in different ways, they depend on various factors, such as psychological components and sociocultural influences, that can either have a positive or negative influence on health-related behaviors.^{31,32} The extent and associations of body image dissatisfaction and weight perception have been identified within previous literature.^{6,9,11,15,17,33} An increase in body image dissatisfaction is associated with an increase in desirability for higher muscle mass, consumption of energy-dense foods, and in participation of weight control behaviors that include skipping meals, fasting, and restricting intake of food.^{9,11,17,34} Likewise, those who misperceive their body weight tend to also partake in weight control behaviors, such as skipping breakfast and eating less than desired.^{6,15,33} More emphasis is placed on gathering evidence of eating disorder risk and weight control behaviors in body image and weight perception studies. However, there is a lack of evidence in assessing the associations between BWD and overall DQ within the college-aged population.

Assessment of Dietary Intake and Quality

To obtain DQ, the common intake of the participant must be gathered and analyzed. Many formats, surveys, and questionnaires have been formulated specifically to gather pertinent information about an individual's dietary habits and

overall common intake. In both the clinical and research setting, the following dietary assessment tools have been utilized to gather such information: 24-hour recall, 3-day food diary, and Food Frequency Questionnaire (FFQ).^{35,36} A FFQ questions participants on usual frequency of food and supplement consumption for a specific time period (days, weeks, months, a year, etc.), whereas 24-hour recalls and 3-day food diaries gather detailed dietary information from days prior.³⁶ Although 24-hour recalls and 3-day food diaries are more accurate in obtaining detailed dietary information, the FFQ is more ideal for gathering common dietary intake in epidemiological and large sample-based studies.^{35,36}

A FFQ was developed by the National Cancer Institute (NCI) in 2001 termed ‘The Diet History Questionnaire (DHQ)-I’ to gather information on 124 food items, portion size, and supplement use in participants.³⁷ This DHQ has been validated against other common FFQs and has been found to be as good as, or superior to, Block and Willett FFQs.³⁶ The DHQ-I has since been updated to the DHQ-II which now consists of 134 food items and eight dietary supplement questions to better understand the intake of research participants.³⁷ Once common dietary intake of the participant is gathered, the DQ can be evaluated through DQ indices. The dietary intake data can be assessed and analyzed through various tools such as surveys formulated by researchers, or algorithms that have been validated and created for future research. Surveys that have been utilized in previous literature include the Rate Your Diet survey, Five-Factor Screener, and surveys that have been formulated by researchers to gather information on food groups such as fruits and vegetables.^{26,38,39} Although these

tools can be useful in analyzing an individual's DQ, there are alternative DQ indices that are superior for the purpose of research.

Measures of DQ commonly used in research settings include, but are not limited to, the HEI, the Alternative Healthy Eating Index (AHEI), and Dietary Approaches to Stop Hypertension (DASH).^{40–44} The HEI was first created in 1995 by the U.S. Department of Agriculture to determine Americans' adherence to guidelines and the food pyramid.⁴² It is not only a valuable tool to assess DQ in research, but also in population monitoring, evaluation of the food environment, food assistance packages, and nutrition interventions.⁴⁵ In 2002, the AHEI was created based on the original HEI and was constructed on food and nutrient intake predictive of chronic disease risk with a higher score indicating lower risk of major disease.^{43,44,46} Although this is a valid tool to use in research populations, it is more appropriate for populations with increased disease risk such as cardiovascular disease, heart failure, diabetes, etc.^{43,44}

Since the release of the HEI, it has been updated to the 2005, 2010, and newly revised 2015, versions which each reflect the changes that are implemented in the revised *National Dietary Guidelines for Americans* (DGA). The 2005 HEI included 12 components expressed as ratios of a food group or nutrient intake to energy intake.⁴⁷ The components were scored as the following: “0 to M, where M is 5, 10, or 20.”⁴⁷ Although the 2010 HEI remained with 12 components, the scoring of the HEI changed to a total score out of 100. This score is indicative of overall DQ, as well as separate scores of adequacy and moderation to reveal a pattern of quality.⁴⁸ The 2010 HEI components were reflective of the 2010-2015 DGA, with nine adequacy

components including: total fruit, whole fruit, total vegetables, greens and beans, whole grains, dairy, total protein foods, seafood and plant proteins, and fatty acids.⁴⁵ The remaining three were refined grains, sodium, and empty calories (energy from alcohol, added sugars, and solid fat) known as moderation components.⁴⁵ The list of components remained the same for the 2015 HEI, however, the total components and moderation components were adjusted with the newly revised 2015-2020 DGA. Since quantified limits for added sugars and saturated fats were defined in the new 2015-2020 guidelines, empty calories from the 2010 HEI moderation components were replaced with added sugars and saturated fats making a total of 13 components.⁴⁸ Another change that was made for the 2015 HEI is the allocation of legumes. Previous versions of the HEI allocated legumes as either a vegetable or a protein food component, but not both through the algorithm.⁴⁸ In the 2015 HEI, legumes are now allocated in either total vegetables, greens and beans, total proteins, or seafood and plant proteins.⁴⁸ This development in the 2015 HEI may be beneficial in gathering more accurate DQ results for those who consume mainly plant-based diets such as vegetarians and vegans.⁴⁸

Although the HEI is valid and reliable DQ measure, it does possess some marked limitations. For instance, there are multiple ways to arrive at the same total score since it is based on the sum of adequacy and moderation components.⁴⁹ For this reason, examining component scores to assess what particular components led to a high or low score is necessary. Second, the HEI scores are truncated and are unable to capture excessive intakes which could be explored further.⁴⁹ Lastly, like many dietary intake data, it is based on self-reported behavioral variables which leaves much room

for measurement error.⁴⁹ While the HEI does possess some limitations, the total score and components still remain in line with the DGA and gather pertinent dietary information for research.

Influences of Dietary Intake and Quality

The term DQ is defined as ‘the consumption of a variety of food groups and nutrients that support bodily growth and maintenance of normal weight, physiological status, and PA.’⁵⁰ According to the 2015-2020 DGA, DQ measured through the 2010 HEI continues to be low (mean total HEI score of 57.8) for all age groups as overweight and obesity continues to rise.⁵¹ The DGA states that Americans continue to consume less nutrient-dense foods such as fruits and vegetables with an increase of highly processed foods.⁵¹ Although DQ is low among all age groups, young adults have been shown to have lowest adherence to dietary guidelines compared to older counterparts.⁵² In a cross-sectional study evaluating the validity and reliability of the 2015 HEI, the means across age groups were significantly different for total HEI score and dietary components.⁴⁹ Older adults (>60 years of age) presented with a higher mean total HEI score of 62.8 ± 1.1 compared to younger adults (20-39 years of age) with a mean total score of 55.0 ± 0.7 .⁴⁹ Similarly, another study⁴⁵ examining the validity of the 2010 HEI found that older group of adults (>51 years of age) had a significantly higher mean total HEI score of 56.1 ± 0.6 compared with the younger group of adults (20-30 years of age) with a mean total score of 45.4 ± 1.1 . Overall, results from previous literature present that young adults tend to have lower overall DQ than older adults.

Young adults may possess poor dietary habits that can lead to lower DQ such as skipping meals frequently, consuming energy-dense snacks between meals, and increasing consumption of fast food and alcohol.^{33,53,54} These habits have been found to be associated with major in college, residency on and off campus, sex, and BMI.^{24,34,45,49,53,55,56} In 2012, Amaral et al.⁵³ analyzed body weight satisfaction and DQ in female college students and assessed if major or field of knowledge impacted results. The sample included female volunteers from majors of Nutrition and Dietetics (n=29) and Social Work (n=18). A validated FFQ was utilized to obtain dietary intake and a Diet Quality Index was used to obtain DQ. The mean total score was low (38.5 ± 6.7) for both majors with 83% of total participants classified as “needs to improve” based on score. However, the Nutrition and Dietetics majors had higher Diet Quality Index scores (41.5 ± 5.1) compared to the Social Work majors (33.7 ± 6.5). The study concluded that the background and knowledge of nutrition and health may impact eating behaviors and influence overall DQ.⁵³

Similar to field of knowledge, residency on or off campus may influence dietary intake and DQ. A 2013 cross-sectional study by Pelletier and Laska⁵² examined the association between college students’ dietary patterns and frequency of purchasing foods on or off campus. The results showed that male and female students living off campus presented with healthier dietary patterns compared to those living on campus. Specifically, bringing food from home was associated with lower fat and added sugar intake with a higher intake of dairy, fruits and vegetables, calcium, and fiber.⁵² Although the results from this study included both males and females, various

studies show consistent results in regards to the differences by sex for dietary intake and DQ.

Similar to BWD, previous research has analyzed dietary intake and DQ in all age groups but shows varying results by sex.^{45,49,55,57} Between males and females, females tend to present higher overall DQ with a higher intake of vegetables, fruits, and whole grains when compared to males.^{49,55,57} In a 2019 cross-sectional study, Sunbul et al. evaluated the DQ of college students utilizing the 2015 HEI to assess adherence to the 2015-2020 DGA.⁵⁷ The sample included college students (n=669) categorized into three groups (under-fat, normal, or obese) based on %BF measured by the Tanita bioelectrical impedance analysis device. Dietary intake was gathered utilizing the NCI DHQ-I and analyzed for quality through the 2015 HEI. The results showed that females had a significantly higher total HEI score (63.82 ± 9.0) than males (61.24 ± 8.7). The total score for females was weighted by higher intake of total fruits, total vegetables, whole grains, and greens and beans, whereas males tended to have a higher intake of total protein foods.⁵⁷ Similarly, another study⁴⁵ utilizing the 2010 HEI found men had a significantly lower mean total HEI score (49.8 ± 0.6) than women (52.7 ± 0.9). Like Sunbul et al., women had a higher intake of five of the 2010 HEI components including total vegetables, greens and beans, whole fruits, total fruits, and dairy.⁴⁵ Overall, females tend to exhibit higher DQ with greater intake of fruits, vegetables, dairy, and whole grains when compared to males.

As dietary intake and DQ has been shown to differ by sex, intake has also been shown to differ by BMI category within the college population. A cross-sectional study by Brunt et al.⁵⁸ assessed whether differences existed between groups, or kinds

of foods, and BMI categories. The sample included undergraduate students (n=557), aged 18-56 years, with BMI calculated through self-reported height and weight. Dietary intake was assessed through the Diet Variety Questionnaire, which consists of 42 items of which are common foods college students consume. The analysis indicated that those with overweight or obese ($\text{BMI} > 25 \text{ kg/m}^2$) status were more likely to consume meats and fish (pork, lamb, veal, game, and fish). Underweight students ($\text{BMI} < 19 \text{ kg/m}^2$) were more likely to consume cheese, green leafy vegetables, and other vegetables.⁵⁸ Although these results identify associations with BMI categories and dietary intake, it does not assess the associations it has with overall DQ.

As previously stated, weight misperception, and dissatisfaction of weight and image can have a negative influence on young adults' dietary intake and DQ.^{6,9,11,15,17,33,34} Similar findings have been found in previous literature in regard to associations between BWD and dietary intake. It has been identified that those who are satisfied with their weight tend to consume more fruits and vegetables,²⁴ compared to those who are more dissatisfied reporting more disordered eating behaviors, consuming fewer meals per day, and snacking more regardless of weight category.^{10,13} Although these results have been identified, minimal research has identified associations between overall BWD and DQ measured by the DQ indices, specifically in college-aged students.

Although minimal, BWD and DQ has been examined in the adolescent population. However, it does not address their adherence to the recently updated DGA. A 2018 cross-sectional study, conducted by Xu et al.,²⁷ examined the association between adolescents' weight status, perception, and satisfaction, and clustering of PA

and dietary behaviors. Data were examined for adolescents aged 12-17 years (n=2,965) from the National Health and Nutrition Examination Survey and the U.S. Department of Agriculture's Food Patterns Equivalents 2007-2014.²⁷ Weight satisfaction was determined through single-item questions and DQ was measured by the 2015 HEI scoring algorithm. Females who were satisfied with their weight were more likely to partake in both PA and consume a healthier diet compared to those females who were dissatisfied. These findings were not observed in the male participants. Although these findings of this study indicate differences by sex for satisfaction, participants were stratified into tertiles for DQ and clustered by PA and dietary behaviors. Rather, the adherence to the DGA was not examined within this study.

Another study⁵³ analyzed body weight satisfaction and DQ in a group of female university students. The sample included normal-weight females with a mean age of 20.0 ± 1.3 , in their second or third year majoring in Nutrition and Dietetics or Social Work (n=47). Weight satisfaction was determined through self-reported weight and desired body weight. Dietary intake was assessed through a validated FFQ and was analyzed for DQ through the Diet Quality Index. DQ was defined as "good" (>48), "needs to improve" (30.6-48) and "poor" (<30.6). The results from the study found that although the sample included normal-weight females, more than half of the sample (57.4%) were dissatisfied with their weight, with 14.9% being highly dissatisfied. Results also found the mean score for DQ was 38.5 ± 6.7 with 83% of participants as "needs to improve." Overall, many participants were dissatisfied with their weight with a greater desire to weigh less. Although that study found results for

weight satisfaction and DQ through the Dietary Quality Index with relation to major, it does not address the associations or differences between DQ and magnitude of BWD. For this reason, more research must focus on the associations between magnitude of BWD and the overall DQ in college-aged students in accordance with the 2015-2020 DGA.

Body Mass Index vs. Percent Body Fat

Body composition encompasses body weight and the relative amounts of muscle, fat, bone, and other vital tissues of the body.⁵⁹ As body weight continues to rise within the U.S., the need for more accurate measures of body composition is pertinent in order to determine the individuals level of disease risk.⁶⁰ Various methods are utilized to obtain body composition and weight status in participants, whether in the clinical or research setting. BMI is a weight-to-height ratio that is commonly used in research as a predictor of weight status.^{61,62} It has also been utilized in research when %BF data were unable to be assessed through validated measures.^{61,62} However, BMI has been found to be less accurate in predicting health-related weight status due to its inability to differentiate between fat mass and fat-free mass.^{60,61,63,64} A study conducted by Degraeve et al. evaluated whether BMI classification agreed with the %BF obtained, which was estimated through bioelectrical impedance analysis (BIA) (Omron Body Fat Analyzer HBF-306).⁶⁴ The sample included male military candidates (n=448) chosen at random during a medical visit. The main finding of the study was that when BMI was used to estimate %BF, 29 of the candidates classified as overweight (n=73) were false negatives according to measured %BF. These participants possessed a BMI >25 kg/m² categorizing them as overweight, with a

normal %BF as measured by BIA. The misclassification through BMI is possibly due to higher levels of muscle mass. These findings indicate that BMI alone is not an accurate representation of body fatness. Rather, if an individual has an elevated BMI, additional %BF testing should be performed to have accurate results. Another study⁶⁵ found similar results when comparing BMI and %BF measured through tetrapolar multi-frequency BIA. The sample included males and females (n=653) with a mean age of 21.1 ± 2.5 and BMI of 22.7 kg/m^2 . Since the sensitivity was low in comparison to the reference method (BIA), BMI was found to be a poor predictor of overall body fatness.⁶⁵ While these studies indicate BMI is a poor predictor of %BF, one study found results that oppose the previous findings. A 2012 observational study examined associations of BMI and %BF to various aspects of esteem in young adults.⁶¹ When controlling for PA, BMI and %BF resulted in similar degrees of association with body-esteem subscales in both sexes. Therefore, while results should be taken with caution, it may be acceptable to utilize BMI in place of %BF measurement if researchers or clinicians do not have the resources to measure %BF.

Measurements of Percent Body Fat

Since previous literature presents contrasting results in regard to BMI, it is important to gather %BF for more accurate results if resources are available. Other methods that have been recognized as better indicators of body composition in clinical and field settings include, but are not limited to, 3-site or 7-site skinfold caliper measurements, dual x-ray absorptiometry (DEXA), hydrodensitometry (underwater weighing, UWW), air displacement plethysmography (Bod Pod), and single or multi-frequency bioelectrical impedance analysis (BIA).^{60,63,64,66–69} Skinfold caliper

measurement through Lange calipers is a commonly used anthropometric technique to gather %BF.⁷⁰ The method utilizes the sum of 3-site or 7-site skinfolds on marked sites of the body (anterior thigh, anterior iliac crest, subscapular, chest, midaxillary, abdomen, and triceps) with use of predictive equations.⁷¹ This measure is based on the principle that a relationship exists between measurement of subcutaneous fat and %BF.⁷² However, this method of measurement has lower reliability due to high dependency on operator accuracy.^{70,73} For this reason, skilled operators and multiple measures are necessary for increased accuracy.^{70,73} To decrease the chance of operator error, more methods are available for obtaining accurate %BF results.

One measure that relies less on trained or skilled operators, as compared to the amount of training needed for skinfold measurements, includes the Bod Pod. This form of body composition is air displacement plethysmography and indirectly measures body density through the subtraction of the volume of air displaced by the participant in the chamber to the volume of air remaining in the empty chamber.⁷⁴ Some advantages to using this body composition measure includes quick analyzation of results, increased comfort for the participant, is non-invasive, and is a safe measurement process.⁷⁴ Studies have assessed the reliability and validity of the Bod Pod measurement to DEXA and BIA, and have found excellent reliability with repeated measures differing by 0.2%.⁶⁹ However, another study⁷⁵ found it to not be interchangeable for those participants with morbid obesity ($>40 \text{ kg/m}^2$).

Another measure of body composition commonly used in the research and clinical setting, and as a validation and reference tool, is DEXA.^{60,75,76} The DEXA uses a 3-compartment model that separates body mass into bone mineral content, lean

body mass, and %BF.⁶⁰ Although this is commonly utilized as a validation tool due to high accuracy, there are some disadvantages to using this technique. These disadvantages include high-cost which limits accessibility and high risk of radiation exposure.⁶⁰ For these reasons, other forms of body composition measurement such as the single or multi-frequency BIA can be utilized when the DEXA is inaccessible. However, these devices must be validated against the gold standards (DEXA, UWW).^{77,78} Since DEXA has been found to be a valid measure, it has been used in a multitude of BIA validation studies to gather accuracy of %BF and fat-free mass measurements.

BIA is an analyzer that indirectly measures %BF through “the body’s resistance to flow (impedance) of alternating electrical current at a designated frequency between points of contact on the body.”⁶⁰ Since fat-free mass is hydrated, the electrical current passes more easily through the tissue due to the high electrolyte content, with resistance to the electric current being inversely proportional to fat content.⁷⁸ BIA exists in methods of single frequency (hand-to-hand or foot-to foot), or multi-frequency. Each method is dependent on the tactile electrodes and frequencies that it contains, predictive equations, as well as under and over hydration of the participant.⁷⁹

Single frequency and multi-frequency BIA methods have been validated against the gold standard, DEXA, in previous literature. It remains clear that with an increase in electrodes and frequencies, there is more accuracy of the body composition analysis. The hand-to-hand or foot-to-foot, single frequency devices (e.g. Omron Body Fat Analyzer), utilize two electrodes.⁶⁴ Bipolar BIA is commonly used due to

increased convenience, low cost, and less training needed to administer the test.⁸⁰

However, the results obtained are questionable due to the large variations that exist in the differences between DEXA and the single frequency devices.⁸⁰ Although the device is supposed to be representative of total body %BF, it tends to underestimate for those participants with higher overall muscle mass in the arms and higher muscle mass in one arm compared to the other.⁶⁶ Likewise, those with longer arms may have an overestimation of %BF.⁶⁶ Therefore, researchers must take these factors into consideration when using single frequency BIA.

Due to varying results in single frequency analysis, multi-frequency analysis should be utilized for increased accuracy of results. Multi-frequency BIA recognizes that the body includes five distinct cylinders rather than one (right arm, left arm, right leg, left leg, trunk), which allows for regional analysis of fat-free mass, %BF, and total body water.^{60,67} Each cylinders contains a different resistivity and impedance which will alter the results for %BF and segmental water analysis.⁶⁰ Such devices that measure multiple frequencies include the InBody 230, 270, 570, 720, and 770.^{60,67,69,81,82} For the InBody, the electrodes are situated on the handles where palms and thumbs are placed, and on footpads at the base of the platform.^{69,83} Although each device contains electrodes, the frequencies and impedance measurements vary. For example, the InBody 570 measures in three frequencies measured in kilohertz (kHz) (5, 50, 500 kHz) with a total of 15 impedance measurements, whereas the InBody 770 measures in six frequencies (1, 5, 50, 250, 500, 1000 kHz) with a total of 30 impedance measurements.⁸⁴ The increase in frequency and impedance allows for additional results to be obtained such as extracellular water, visceral fat area,

segmental body water analysis, and leg lean mass which presents more in-depth results.⁸⁵

Multiple InBody devices have been validated against DEXA and have shown low variability and excellent reliability.^{60,69,76,83} Von Hurst et al.⁶⁹ assessed the validity of BIA against Bod Pod and DEXA to measure %BF. The results indicated excellent relative agreement to the estimated true value with underestimation by 2% by BIA across all values. Likewise, Anderson et al.⁶⁰ found no observed differences between the InBody 520 and 720 and DEXA in any %BF comparison, besides a 1.6 kg overestimation by 720 in men. Overall, previous studies indicate that due to high correlation with DEXA, multi-frequency BIA is a valid estimator of %BF.^{76,83}

Influences of Body Composition

Previous research consistently shows a positive relationship between BMI, and body image and BWD; the higher the BMI value, the higher the dissatisfaction.^{9,14,32,86} A 2007 cross-sectional study examined body image and weight dissatisfaction in a sample of male and female undergraduate students (n=310) with self-reported BMI.¹⁴ The results indicated that all overweight males and females (BMI >25 kg/m²) expressed the highest BWD and body image dissatisfaction, whereas the underweight and normal-weight females expressed little BWD and body image dissatisfaction.¹⁴ Another study¹⁸ examined the prevalence and predictors of BWD in adults, and assessed BWD in relation to the World Health Organization division of BMI. The sample included participants aged 18 to 79 years (n=5,832) with self-reported BMI. The results indicated that participants within the obese category presented the highest amount of BWD with 77% in males and 87.5% in females. The overweight

participants showed BWD as well with 37% in males and 64% in females within that category. Overall, those with higher calculated BMI tend to have higher BWD and body image dissatisfaction.

Although research has examined BMI in relation to BWD and body image dissatisfaction, minimal research has examined the association between body image and BWD with %BF. Likewise, there is a lack of measurement utilizing multi-frequency BIA, specifically the InBody 770. Previous literature presents an inverse relationship between %BF and body image satisfaction similar to that of BMI. Streeter et al.⁶¹ examined body image in comparison to body composition of participants (n=162) aged 18 to 25 years. The %BF was measured through DEXA, and body image dissatisfaction through three subscales in relation to appearance and esteem. The results indicate %BF was inversely associated with body image, particularly among those with obesity. As %BF increased, body esteem and image decreased. Another study⁸⁷ found similar results with higher satisfaction related to lower %BF. However, %BF was measured via 'Biodynamics BIA 450 Bioimpedance Analyzer.'

Likewise, previous literature shows similar results for BWD and %BF to that of body image dissatisfaction. Arroyo et al.⁹ examined the predictors of the magnitude of BWD in undergraduates, including %BF through skinfold calipers and self-reported BMI. The results indicate that 71% of participants were dissatisfied with %BF with higher levels of %BF leading to greater dissatisfaction. The limitation within this study was utilizing skinfold calipers to gather %BF which increases risk of operator error and inaccurate results. Likewise, another study²⁴ found that adults with weight satisfaction had a lower BMI (23.8 kg/m² vs. 27.9 kg/m²), and lower %BF (18.8% vs.

28.8%) compared to those participants with BWD.²⁴ The %BF was measured through skinfold calipers or hydrostatic weighing. Although hydrostatic weighing and skinfold calipers have been found to have no difference in %BF results, obtaining %BF through skinfold calipers still leaves room for error.⁷¹ Overall, previous literature shows similar results for %BF in regards to body image dissatisfaction and BWD; an increase in BWD is associated with higher %BF. Although previous research shows the associations of BWD with BMI and %BF, minimal research focuses on BWD and the measurement of %BF via the InBody 770 and Bod Pod in the college-aged population.

Physical Activity

PA is defined as any bodily movement that increases energy expenditure through muscular contraction, whereas exercise refers to “planned, structured, repetitive, and performed” movement that is a form of PA.⁵⁹ All exercise can be a form of PA, but not all PA is considered exercise.⁵⁹ In an effort to improve the health and fitness of the public, the first edition of the *Physical Activity Guidelines for Americans* was released in 2008 by the U.S. Department of Health and Human Services.^{59,88} Since then, the second edition was released in 2018 due to emerging scientific evidence aspects of PA and fitness.⁵⁹ The guidelines provide all age groups and populations with minutes of weekly aerobic MVPA, and the number of days for muscular strengthening activity with intensity.^{59,88} In a joint effort to improve overall health, these guidelines can be used in combination with the DGA to provide the public with science-based evidence on the benefits and importance of physical fitness and healthful eating.⁵⁹

The 2008 *Physical Activity Guidelines for Americans* recommend that adults partake in at least 150 minutes of weekly aerobic moderate-intensity activity, or 75 minutes of weekly aerobic vigorous-intensity activity.⁸⁸ Additional benefits can be obtained if moderate-intensity is increased to 300 minutes per week, and vigorous-intensity to 150 minutes per week.⁸⁸ The aerobic activity can be performed in bouts of at least 10 minutes to obtain the goal of moderate- or vigorous-intensity activity.⁸⁸ The 2018 guidelines has similar recommendations: at least 150 to 300 minutes of weekly aerobic moderate-intensity PA, or 75 to 150 minutes of weekly aerobic vigorous-intensity PA.⁵⁹ However, the bouts of 10 minutes to achieve PA recommendations was removed and replaced with the goal of increasing overall movement throughout the day.⁵⁹

Measurement of Physical Activity

To detect if age groups and populations are adhering to the guidelines, it is necessary to measure progress and activity through valid and reliable instruments. Within the literature, there are various instruments used that are either objective or subjective tools that measure PA. Some include accelerometers or pedometers, which are objective tools, or surveys such as the National College Health Risk Behavior Survey, 7-Day Physical Activity Recall, or International Physical Activity Questionnaire (IPAQ), which are subjective tools.⁸⁹⁻⁹² Accelerometers and pedometers are considered quantitative measurements that directly measure the PA of the participant.⁹⁰ Since these tools give a direct measurement, they are often used to validate PA surveys, such as the IPAQ.⁹⁰

The IPAQ is self-reported assessment tool utilized to gather the amount of PA a participant completed over the past seven days. This assessment tool is offered in a long or short form, and gathers participation estimates in multiple domains of PA including transportation, occupation, house/lawn, and leisure time.^{90,92,93} The long form provides detailed information about time spent in each domain, whereas the short form uses a sum of the scores to obtain a total score of PA.⁹³ Weekly vigorous activity, moderate activity, and walking are assessed and determined by multiplying the frequency and duration of each category of activity.^{90,92} In order to utilize a survey such as the IPAQ, it should first be validated. A validation study was conducted Dinger et al.,⁹⁰ examining the validity and reliability of the IPAQ short form in college students. The sample size included male and female undergraduate students (n=123) aged 18-30 years. The students were to wear an accelerometer and pedometer at their waists for seven consecutive days. At the end of the seven days, the participants would complete the IPAQ. The results indicated that the time spent in vigorous PA from the IPAQ was significantly correlated with steps per day from both the accelerometer and pedometer ($p<0.01$), whereas the time spent in moderate PA was significantly associated with the accelerometer ($p<0.05$).⁹⁰ The results of the study show the IPAQ responses were similar to that of the activity measured by the accelerometer and pedometer. Although it may be a reliable survey to use in place of a direct measurement tool, it is important to note the survey still may contain error due to self-report response bias.

Influences of Physical Activity

While the guidelines are created for Americans to follow to improve overall health, previous data show only half of the U.S. population adhered to the 2008 guidelines.⁹⁴ To date, there are no national data on U.S. adults adherence to the newly revised 2018 guidelines. According to the early release of the National Health Interview Survey (NHIS), from January to September of 2016, about half of the U.S. adults (52.8%) over the age of 18 met the 2008 guidelines for aerobic PA. Although the percentage increased from January to September of 2017 (53.8%), this difference was not significant.⁹⁴

Significant improvements are not shown for participation in PA for the whole population. However, differences have been found between sexes for participation in PA, where males tend to be more physically active than females.^{27,59,90,94,95} In the NHIS, when adults were categorized by age group (18–24, 25–64, 65–74, and 75+), women in all age groups were less likely than men to meet the 2008 guidelines for aerobic activity.⁹⁴ It has also been found that when observing the college-aged population of adults (18-24 years of age), females participate in less PA (56.8%) than males (67.7%) with a total of 62.2% of males and females meeting the guidelines for aerobic PA.⁹⁴ Likewise, in the validation study by Dinger et al.,⁹⁰ students overall reported engaging in 589.4 ± 404.9 minutes of total PA per week with males reporting significantly more time in vigorous PA than females ($p=.003$). Overall, men tend to participate in more PA than females. However, U.S. adults are still not meeting the recommended frequencies and durations for aerobic PA.

Influences of Physical Activity

It is apparent that U.S. adults are not meeting the recommended amounts of aerobic PA. The reasoning for engagement in PA, or lack thereof, varies from person to person. Many individuals are active because it increases energy and health, whereas others are inactive due to body image dissatisfaction or their perception of their own ability.^{59,62} Associations have been made between %BF, weight status, and BWD to participation in PA. In previous research, it has been shown that those with a lower %BF and are weight satisfied participate in more regular PA with higher levels of walking/jogging per week and higher cardiorespiratory fitness compared to those with higher %BF and BWD.^{7,13,24,87} With regards to BWD, it has been shown that those who are dissatisfied with weight tend to be less physically active, compared to those who are satisfied with weight.^{13,27} In a cross-sectional analysis conducted by Blake et al.,¹³ men and women satisfied with their weight engaged in more PA compared to those dissatisfied with their weight with lower levels of PA as indicated by lower treadmill time and metabolic equivalents of task (METs). From Blake et al. and previous literature, it would be expected that those with higher BWD would have lower levels of PA. However, one article¹⁰ presents contrasting results with active individuals reporting higher BWD than inactive individuals, possibly due to their desire to change weight status. Although literature has examined the association of BWD and PA, there is a lack of research in the college-aged population between BWD and minutes of weekly aerobic MVPA utilizing the newly revised *2018 Physical Activity Guidelines for Americans*.

Conclusion

The increase in BWD has been identified as one of the behavioral patterns related to the development of eating disorders which can lead to detrimental behaviors that are associated with DQ, %BF, and participation in PA.^{1,2,6,8,11,14,21,22} Previous literature identified the overall DQ of the college-aged population, and the association DQ has with body image and weight misperception. However, minimal research focuses on BWD and fails to evaluate the overall DQ in accordance with the DGA utilizing the 2015 HEI. Likewise, research identified the relationship between BMI and BWD with a higher BMI value being associated with higher dissatisfaction.^{9,32,86} However, minimal research focuses on BWD and the direct measurement of %BF via the InBody 770 or Bod Pod in the college-aged population. Lastly, previous literature has shown that those with a “healthy” BMI, lower %BF, and weight satisfaction participated in more regular PA with higher levels of PA compared to those with higher %BF and weight dissatisfaction.^{7,13,24,86,87} Although literature has examined the association of BWD and PA, there is a lack of research in utilizing the newly revised *2018 Physical Activity Guidelines for Americans* to obtain data on minutes of weekly aerobic MVPA in the college-aged population. Overall, there is a need for research regarding the magnitude of BWD and the association it has with high or low DQ, high or low %BF, and high or low weekly minutes of moderate to vigorous PA.

APPENDIX B: Extended Methods

Study Design

The NAS is an ongoing IRB-approved study at URI that aims to examine nutrition assessment data for research to help us understand the relationship between diet and disease risk in college students in an Applied General Nutrition course (NFS 210). This study involved gathering anthropometrics, physical activity, dietary data, and blood values through assessments that are required as part of their coursework. This cross-sectional, secondary data analysis investigated data that was collected in the NAS from college-aged students, aged 18-24 years old, during semesters in Fall 2015 to Fall 2019.

The independent variable was BWD. This was a quantitative independent variable defined as the absolute value of the difference between measured body weight in pounds and desired weight reported by the participant on the demographic survey. A median split of BWD was used to categorize the independent variable into higher or lower BWD. The results include both the true value and the absolute value. A higher absolute value indicated a higher BWD and a greater desire to change weight, whereas a lower absolute value indicated lower BWD and a lesser desire to change weight. The dependent variables were total HEI score, body composition, and physical activity. The primary dependent variable was total HEI score and examined the associations between BWD and DQ utilizing the total 2015 HEI score in college-aged students. The secondary dependent variable was body composition and determined the relationship between BWD and body composition, measured as %BF through the Bod Pod or InBody 770. The tertiary dependent variable was physical activity and

evaluated the association between BWD on minutes of moderate to vigorous physical activity per week measured by the International Physical Activity Questionnaire (IPAQ).

Research Participants

The sample was drawn from the Applied General Nutrition Course (NFS 210) at URI. Convenience sampling was completed to determine the required sample size for the primary dependent variable from Fall 2015 to Fall 2019. Predetermined inclusion criteria were used, such as students enrolled in NFS 210 lab, male and female, and from 18 to 24 years of age. Students were excluded if they were not enrolled in NFS 210 lab and course, were below 18 years of age, above 24 years of age, pregnant, or had reported energy intakes of <400 and >7,000 kcal/day. This age group was selected to be consistent with other research conducted in college student populations and due to the lack of literature that addresses this age group in particular for BWD.^{32,33,61,62,64}

Data Collection

All data collection occurred during the course lab sessions throughout the semester. Protocol guidelines were in place for all assessments including anthropometrics, blood values and survey data within the NAS Manual. Undergraduate and graduate teaching assistants and research assistants were trained on proper protocols before participating in data collection which included anthropometrics, blood values, survey measures and data collection techniques.

During the first lab session, students were provided with verbal and written information about the research study which was described in detail in the informed

consent form (Appendix C). In order to participate, potential participants were required to meet the following criteria: 18 years of age, and enrolled in the NFS 210 course lab; no consent form was accepted from any participant that was under the age of 18 and not enrolled in the course. The student was to be given two copies of the informed consent form; one form was kept by the participant and the second was signed and collected by undergraduate and graduate assistants. Once the students completed the consent form or declined to participate, the consent forms were collected and placed in a folder that is labeled for storage for five years. Each participant then received a username and login password that gave them access to the NAS survey, the Diet History Questionnaire II (DHQ II), and the IPAQ.

The NAS survey, also known as the demographics survey, was administered during lab two and was completed within one lab session. The NAS survey is an electronic survey that should take no longer than 15 minutes to complete. It includes 26 questions varying in number of items per response with response formats including multiple choice, open-ended, and Likert scale. When the NAS survey was administered, the students were required to complete the survey within the timeframe of the lab session. The overall NAS survey has not been validated, but has been utilized in previous research as a tool to gather pertinent demographic data. The students were to login to the NAS web portal with their URI student ID number to access the survey. Students then selected the NAS and completed it. The NAS survey was created originally by Dr. Greene at URI to assess basic demographic information, body weight satisfaction, eating rate, and sleep duration and patterns.

The IPAQ was also administered in lab two and was to be completed within one lab session. The students were required to log on to the web portal with their proper URI ID number and complete the questionnaire, which took approximately 10 minutes for the students to complete. Blood values were collected during week five, lab four, outside of the weekly lab session in the Common Intake Room in the Nutrition and Food Sciences building at URI. The results included total cholesterol, low density lipoprotein cholesterol (LDL-C), high density lipoprotein cholesterol (HDL-C), triglycerides, and fasting blood glucose. The values were collected using the Alere Cholestech® LDX System after a fast of a minimum of 12 hours.

The DHQ II was administered during two lab sessions. Part 1 of the DHQ II was completed during lab seven and part two was completed by lab nine. Before the start of the lab, the graduate research assistant assigned DHQ II logins using the students' URI ID number. The undergraduate teaching assistant distributed the assigned DHQ II login and passwords to the proper student preceding the start of lab seven. The students were required to log on and complete the DHQ II in lab, which took approximately 1 hour and 15 minutes to complete.

Anthropometric measurements were assessed and collected during week nine, lab six, outside of the weekly lab session in the Common Intake Room in the Nutrition and Food Sciences building at URI. All anthropometric measurements were collected by trained undergraduate and graduate teaching and research assistants. The students signed up for an allotted time (15-minute time slot) to complete the anthropometric measurements which included height and weight to calculate their BMI, waist and hip circumference, and body composition using the InBody 770. Height was assessed

using a wall-mounted stadiometer (SECA 240, Hamburg, Germany) and rounded to 0.1 cm. Subjects were to follow proper protocols to obtain accurate results.⁹⁶ Weight was assessed using a digital scale (SECA 700, Hamburg, Germany) and was rounded to 0.1 kg. Body fat percent was measured utilizing the Bod Pod or InBody 770. The Bod Pod (Life Measurement Inc. Concord, CA) gathers body fat percent through air displacement plethysmography.⁷⁴ The InBody 770 utilized voice commands to guide the user through the InBody Test.⁶⁰ Students were to remove shoes, socks, heavy articles of clothing, and items in pockets.⁶⁰ They wiped their hands and feet with an InBody tissue or wipe.⁶⁰ They stood on the device barefoot and aligned their heel with the round silver electrodes and the rest of the feet with the foot electrode.⁶⁰ After weight was measured, the student input their age, height and sex.⁶⁰ When prompted, the student grabbed the hand electrodes, and kept arms relaxed and extended slightly away from the torso (roughly 15 degrees).⁶⁰ The InBody 770 test took approximately 60 seconds and the results printed automatically after testing.⁶⁰

Variable Instruments

Body Weight Dissatisfaction: NAS Survey

Each dependent variable was assessed utilizing a different instrument. The independent variable, which is BWD, was evaluated by utilizing the NAS survey. This survey gathered pertinent information to help differentiate between the students' actual weight versus their desired weight and categorize students as those with high or low BWD. Questions that were used for this differentiation included, "What would you like to weigh in pounds," with an open-ended response category, "How would you describe your current weight," with response categories including: very underweight,

slightly underweight, about the right weight, slightly overweight, very overweight, or I choose not to answer, and “How do you feel about your current weight,” with response categories including: I am happy with my current weight, I don’t care about my current weight, I am upset about my current weight, or I choose not to answer. The NAS survey gathered pertinent information on demographics as potential covariates. These included multiple choice questions on the current major, age, and sex of the participants.

Dietary Quality: DHQ II & HEI-2015

The primary dependent variable, DQ, was determined utilizing data from the DHQ II (Appendix F) and was defined as total HEI-2015 score. The DHQ II is the food frequency questionnaire (FFQ) that provided an estimation of total daily caloric intake and evaluated dietary quality by utilizing the HEI-2015.^{37,49} The HEI-2015 is a dietary quality index that measures the alignment with the DGA. The HEI-2015 has been shown to correlate positively with most nutrients in the diet, with BMI, and with individual’s self-perception of diets.⁴⁴ The DHQ II was designed and tested by the National Cancer Institute.³⁷ The DHQ has been validated as a superior FFQ compared to the Block and Willett FFQ for estimating absolute intakes in participants 20-70 years of age.³⁶ The HEI-2015 score was derived from the DHQ II, an FFQ that includes questions on 134 food items and eight dietary supplements.³⁷ The DHQ II questioned the participant about food items and the portion size that was consumed within the past year.^{35,37} The HEI-2015 is an index ranging from zero to one-hundred, which is based on thirteen individual components with scores per item from zero to ten with nine adequacy components: total fruits, whole fruits, total vegetables, greens

and beans, whole grains, milk/dairy, total protein foods, seafood and plant proteins, and fatty acids. It also includes four limited components: refined grains, sodium, added sugars, and saturated fat.⁴⁹ The HEI-2015 is updated every five years to reflect current federal dietary advice through a collaboration between the National Cancer Institute, and the US Department of Agriculture Center for Nutrition Policy and Promotion.⁴⁹ The output scores were calculated through the HEI-2015 algorithm within SAS software (SAS Institute Inc. version 9.4).

Percent Body Fat: Anthropometric Measures

The secondary dependent variable, percent body fat (%BF), was assessed using the Bod Pod or InBody 770, a wall-mounted stadiometer, and digital scale. Height was assessed using a wall-mounted stadiometer (SECA 240), and weight was assessed using a digital scale (SECA 700).⁹⁶ Subjects and undergraduate and undergraduate assistants were to follow proper protocol for accurate results.⁹⁶ Lastly %BF, which is the total mass of fat divided by total body mass, was measured using the Bod Pod or InBody 770.⁶⁰ The Bod Pod measures the volume of air displaced inside the chamber by the participant by subtracting the volume of air that remains inside the chamber to when then volunteer is not within the chamber.⁷⁴ The InBody 770 is a multifrequency BIA device that measures the body's resistance to flow of alternating electrical current at a designated frequency.⁶⁰ It has been found that the InBody 770 is a valid and reliable measure of body composition in relation to DEXA.^{60,81}

Physical Activity Assessment: IPAQ Short-Version

The tertiary dependent variable, physical activity, was assessed using the IPAQ. The IPAQ is an electronic, seven item self-report instrument that with response

format of open-ended questions.⁹⁰ The IPAQ is a self-administered instrument that required participants to report the frequency and duration of vigorous, moderate, and walking activities (10 minutes at minimum during the last seven days).⁹⁰ Weekly time spent in vigorous activity, moderate activity, and walking was determined by multiplying reported frequency and duration within each category of activity. This variable was calculated as minutes of moderate to vigorous physical activity per week.⁹⁰

Statistical Analysis

The statistical analysis package SPSS (IBM version 26.0 SPSS Inc.) was used to perform statistical analyses. Outliers were identified and excluded since there were significant differences in data when included. Skewness and kurtosis were used to assess normality of data distribution. A median split of BWD was used to categorize the independent variable into higher or lower BWD for the whole sample and stratified by sex. To assess between group differences, independent t-tests were conducted for demographic data for the whole sample and stratified by sex. To assess statistical differences between lower and higher BWD, analysis of variance (ANOVA) was conducted for the following main outcomes: mean HEI-2015 score, %BF, and IPAQ moderate-to-vigorous physical activity. Analysis of variance (ANOVA) were run to determine effect size and post-hoc power analysis for the main outcomes. Given the methodology differs for Bod Pod and InBody 770, the two systems were combined for analysis showing no statistically significant difference between the two systems ($p=0.75$). Likewise, previous literature are consistent with this finding showing relative agreement between InBody and Bod Pod, differing by less than 0.2%.⁶⁹ For

this reason, we combined the two measurements for the analysis of %BF. Pearson correlations were run with magnitude of BWD for 1) HEI-2015 component scores, 2) dietary components including total fat and dietary fiber in grams, 3) %BF and BMI. Additional Pearson correlations were also run between %BF and BMI. Acceptance of significance was identified as $p < 0.05$.

APPENDIX C: Informed Consent Form (Valid: 11/27/19-12/5/20)

THE
UNIVERSITY
OF RHODE ISLAND

COLLEGE OF
HEALTH SCIENCES

DEPARTMENT OF NUTRITION AND FOOD SCIENCES
125 Fogarty Hall, Kingston, RI 02881 USA p: 401.874.2253 f: 401.874.5874 web.uri.edu/nfs

Title of Project: Nutrition Assessment Secondary Data Analysis

INFORMED CONSENT TO PARTICIPATE IN RESEARCH

You are invited to take part in a research project described below. Students enrolled in NFS 210 and NFS 443 currently have anthropometric and biochemical assessments and complete dietary assessment as part of their coursework. These assessments are used for classroom assignments. We are asking you to give us permission to use these data for research. In addition, we are asking you to complete a few additional demographic and dietary questions. The purpose of the research is to validate assessment methodologies and to investigate the relationship between anthropometric, biochemical, and dietary variables that are related to chronic disease risk. If you have questions you may contact the Geoffrey Greene, the person mainly responsible for this study at 874-4028 or email him at gwg@uri.edu.

Description of the Project:

The purpose of the study is to use nutrition assessment data for research to help us understand the relationship between diet and disease risk in college students.

My Participation

You must sign this informed consent form for the data collected as part of this class to be used for research, and must complete the additional brief questionnaire.

What will be done:

If you take part in this study, your information entered into a password protected computer. Your data will be identified by code number only. Once all data have been entered and verified, the link between code number and identifying data will be destroyed. All data analysis will be conducted by code number only. Assessments that we will be using are listed below (these are collected as part of your class and the additional brief demographic questionnaire):

Demographics	✓
Dietary Assessment	✓
Height, Weight	✓
Waist and Hip Circumference	✓

The University of Rhode Island is an equal opportunity employer committed to community, equity, and diversity and to the principles of affirmative action.

IRB NUMBER: HU1112-069
IRB APPROVAL DATE: November 27, 2019
IRB EXPIRATION DATE: December 5, 2020

Bioelectric Impedence (InBody)	✓
Sonographic Measurement of the Heel (bone density)	✓
Standard Blood Tests (TG, HDL, LDL, Total Cholesterol, Glucose)	✓

Risks or discomfort:

The risks are minimal. The only risks would be loss of confidentiality and that will be minimized as described below.

Benefits of this study:

You will not receive any direct benefit. Allowing us to use your data and filling out the brief questionnaire will help us with research to better understand the relationship between diet and chronic disease in college students.

Confidentiality:

Your part in this study is confidential. None of the information will identify you name. We will keep all consent forms in a locked cabinet in Room 146 Fogarty for five years. All information collected for the class will be identified by code numbers and will not include any link to your name. This information will be confidential.

Decision to quit at any time:

You have been given the opportunity to decide whether or not to participate in this study. Your decision to participate will not affect your grade in the class or your relationship with your class instructor. Your instructor will not know who is participating in this study. You have the right to stop participating at any time, but once data have been entered and verified and the link between participant and code has been destroyed, we will not be able to remove your data.

Rights and Complaints:

If you are not satisfied with the way this study is performed, you may discuss your complaints with Geoffrey Greene (401-874-4028) anonymously, if you choose. In addition, if you have questions about your rights as a research participant, you may contact the Office of Research Integrity, 70 Lower College Road, Suite 2, University of Rhode Island, Kingston, RI, telephone: (401) 874-4328.

You have read this Consent Form. Your questions have been answered. Your signature on this form means that you understand the information and you agree to participate in the study. Please note that you must be at least 18 years of age in order to participate.

Print Your Name: _____

Signature of Participant Date Signature of Researcher

Please sign both consent forms, keeping one for yourself

IRB NUMBER: HU1112-069
IRB APPROVAL DATE: November 27, 2019
IRB EXPIRATION DATE: December 5, 2020

APPENDIX D: Nutrition Assessment Survey

NAS STARTS

Q1 What is your age?

- 18 (1)
- 19 (2)
- 20 (3)
- 21 (4)
- 22 (5)
- 23 (6)
- 24 (7)
- 25 (8)
- 26 (9)
- 27 (10)
- 28 (11)
- 29 (12)
- 30 (13)
- 31 (14)
- 32 (15)
- 33 (16)
- 34 (17)
- 35 (18)
- 36 (19)
- 37 (20)
- 38 (21)
- 39 (22)
- 40 (23)
- 41 (24)
- 42 (25)
- 43 (26)
- 44 (27)
- 45 (28)
- 46 (29)
- 47 (30)
- 48 (31)
- 49 (32)
- 50 (33)
- 51 (34)
- 52 (35)
- 53 (36)
- 54 (37)
- 55 (38)
- 56 (39)
- 57 (40)
- 58 (41)
- 59 (42)

60 or more years (43)

Q2 What is your gender?

- Male (1)
- Female (2)
- Choose not to answer (3)

Q3 What is your race/ethnicity?

- White (1)
- Black or African American (2)
- Hispanic/Latino (3)
- Asian (4)
- Native Hawaiian or Pacific Islander (5)
- American Indian or Alaskan Native (6)
- Mixed (7)
- Other (please specify) (8)

-
- Choose not to answer (9)

Q4 What is your year in school?

- Freshman (1)
- Sophomore (2)
- Junior (3)
- Senior (4)

Q5 What is your current major?

- Agriculture Sciences (1)
- Biological Sciences (2)
- Business/Communication (3)
- Education (4)
- Exercise Science/Kinesiology (5)
- Fine Arts/Humanities (6)
- Health/Nursing (7)
- Nutrition (8)
- Social Sciences (9)
- Undeclared (10)
- Graduate Student (11)
- Other (please specify): (12)

-
- Choose not to answer (13)

Q6 Place of residence during academic year?

- On campus (1)
- Off campus (2)
- Choose not to answer (3)

Q7 Green Eating is: Eating locally grown foods, limited amounts of processed/fast foods, eating meatless meals at least one day per week, choosing organic foods as much as possible, and only taking what you plan on eating. Are you a green eater?

- No, and I do not intend to start within the next 6 months (1)
- No, but I am thinking about becoming a green eater within the next 6 months (2)
- No, but I am planning on becoming a green eater within the next 30 days (3)
- Yes, I am a green eater and have been for less than 6 months (4)
- Yes, I am a green eater and have been doing so for 6 months or more (5)
- Choose not to answer (6)

Q8 Which of the following best describes the MAJORITY of your meals during the academic year?

- I eat meals prepared at home. (1)
- I purchase frozen or ready-to-eat meals. (2)
- I eat at dining halls/restaurants. (3)
- I get fast food/take-out. (4)
- Choose not to answer (5)

Q9 Do you have a campus meal plan?

- Yes (1)
- No (2)
- Choose not to answer (3)

Q10 What is your usual rate of eating?

- Very Slow (1)
- Slow (2)
- Medium (3)
- Fast (4)
- Very Fast (5)
- Choose not to answer (6)

Q11 Do you experience abdominal discomfort such as cramping, bloating, or excess gas? (this refers to gastrointestinal discomfort, NOT menstrual discomfort)

- Never or very seldom (1)

- Seldom, less than once per month (2)
- Occasionally, a few times per month (3)
- Fairly often, once or twice per week (4)
- Very often, several times per week (5)
- Choose not to answer (6)

Q12 Please select the answer that BEST describes your usual behavior.

	Barely ever to never	Rarely (25%)	Sometimes (50%)	Often (75%)	Almost always	Choose Not to Answer
- Locally grown foods are grown within 100 miles of your location. Based on this, how often do you eat locally grown foods?	☐	☐	☐	☐	☐	
- When in season, how often do you shop at farmer's markets?	☐	☐	☐	☐	☐	
- How often do you choose foods that are labeled certified organic?	☐	☐	☐	☐	☐	
- How often do you select meats, poultry, and dairy products that are raised without antibiotics or hormones?	☐	☐	☐	☐	☐	
- How often do you select food or beverages that are labeled fair trade certified?	☐	☐	☐	☐	☐	
- How often do you buy meat or	☐	☐	☐	☐	☐	

poultry products labeled "free range" or "cage free"?						
--	--	--	--	--	--	--

Q13 Have you smoked at least 100 cigarettes in your entire life? (NOTE: 5 packs = 100 cigarettes)

- Yes (1)
- No (2)
- Choose not to answer (3)

Q14 Do you NOW smoke cigarettes every day, some days, or not at all?

- Every day (1)
- Some days (2)
- Not at all (3)
- Choose not to answer (4)

Q15 What would you like to weigh in pounds? Put CNA if you choose not to answer

Q16 How would YOU describe your current weight?

- Very underweight (1)
- Slightly underweight (2)
- About the right weight (3)
- Slightly overweight (4)
- Very overweight (5)
- Choose not to answer (6)

Q17 How do you feel about your current weight?

- I am happy with my current weight (1)
- I don't care about my current weight (2)
- I am upset about my current weight (3)
- Choose not to answer (4)

Q18 On average, how many hours of sleep do you get in a 24-hour period? Think about the time you actually spent sleeping or napping, not just the amount of sleep you think you should get. How many hours do you usually get each day and night?

- 1 hour or less (1)
- 2 hours (2)
- 3 hours (3)
- 4 hours (4)

- 5 hours (5)
- 6 hours (6)
- 7 hours (7)
- 8 hours (8)
- 9 hours (9)
- 10 hours or more (10)
- Choose not to answer (11)

Q19 Are you often sleepy during the day?

- Yes (1)
- No (2)
- Choose not to answer (3)

Q20 Do you frequently wake up during the time you are asleep?

- Yes (1)
- No (2)
- Choose not to answer (3)

Q21 How would you evaluate the quality of your sleep?

- Not impaired (1)
- Moderately impaired (2)
- Severely impaired (3)
- Choose not to answer (4)

Q22 How many hours before bed to you usually eat your last meal?

- <1 hour (1)
- 1 hour (2)
- 2 hours (3)
- 3 hours (4)
- 4 hours (5)
- 5 hours (6)
- 6 hours (7)
- >6 hours (8)
- Choose not to answer (9)

Q23 What is your usual bedtime?

- before 10:00 PM (1)
- 10:00 PM (2)
- 11:00 PM (3)
- 12:00 AM (4)

- 1:00 AM (5)
- 2:00 AM (6)
- 3:00 AM (7)
- 4:00 AM (8)
- After 4:00 AM (9)
- Choose not to answer (10)

Q24 How many days a week do you usually eat breakfast?

- (1)
- (2)
- (3)
- (4)
- (5)
- (6)
- (7)
- (8)
- Choose not to answer (9)

Q25 Stress management includes regular relaxation and physical activity, talking with others and/or making time for social activities. Do you effectively practice stress management in your daily life?

- No, and I do NOT intend to in the next 6 months (1)
- No, but I intend to in the next 6 months (2)
- No, but I intend to in the next 30 days (3)
- Yes, but I have been for LESS than 6 months (4)
- Yes, and I have been for MORE than 6 months (5)
- I choose not to answer (6)

NAS ENDS

APPENDIX E: International Physical Activity Questionnaire

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE (August 2002)

SHORT LAST 7 DAYS SELF-ADMINISTERED FORMAT

FOR USE WITH YOUNG AND MIDDLE-AGED ADULTS (15-69 years)

The International Physical Activity Questionnaires (IPAQ) comprises a set of 4 questionnaires. Long (5 activity domains asked independently) and short (4 generic items) versions for use by either telephone or self-administered methods are available. The purpose of the questionnaires is to provide common instruments that can be used to obtain internationally comparable data on health-related physical activity.

Background on IPAQ

The development of an international measure for physical activity commenced in Geneva in 1998 and was followed by extensive reliability and validity testing undertaken across 12 countries (14 sites) during 2000. The final results suggest that these measures have acceptable measurement properties for use in many settings and in different languages, and are suitable for national population-based prevalence studies of participation in physical activity.

Using IPAQ

Use of the IPAQ instruments for monitoring and research purposes is encouraged. It is recommended that no changes be made to the order or wording of the questions as this will affect the psychometric properties of the instruments.

Translation from English and Cultural Adaptation

Translation from English is supported to facilitate worldwide use of IPAQ. Information on the availability of IPAQ in different languages can be obtained at www.ipaq.ki.se. If a new translation is undertaken we highly recommend using the prescribed back translation methods available on the IPAQ website. If possible please consider making your translated version of IPAQ available to others by contributing it to the IPAQ website. Further details on translation and cultural adaptation can be downloaded from the website.

Further Developments of IPAQ

International collaboration on IPAQ is on-going and an *International Physical Activity Prevalence Study* is in progress. For further information see the IPAQ website.

More Information

More detailed information on the IPAQ process and the research methods used in the development of IPAQ instruments is available at www.ipaq.ki.se and Booth, M.L. (2000). *Assessment of Physical Activity: An International Perspective*. Research Quarterly for Exercise and Sport, 71 (2): s114-20. Other scientific publications and presentations on the use of IPAQ are summarized on the website.

SHORT LAST 7 DAYS SELF-ADMINISTERED version of the IPAQ. Revised August 2002.

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

1. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

_____ days per week

☐

No vigorous physical activities → **Skip to question 3**

2. How much time did you usually spend doing **vigorous** physical activities on one of those days?

_____ hours per day

_____ minutes per day

☐

Don't know/Not sure

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

3. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_____ days per week

☐

No moderate physical activities → **Skip to question 5**

4. How much time did you usually spend doing **moderate** physical activities on one of those days?

_____ hours per day

_____ minutes per day

☐ Don't know/Not sure

Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

_____ days per week

☐ No walking → *Skip to question 7*

6. How much time did you usually spend **walking** on one of those days?

_____ hours per day

_____ minutes per day

☐ Don't know/Not sure

The last question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the **last 7 days**, how much time did you spend **sitting** on a **week day**?

_____ hours per day

_____ minutes per day

☐ Don't know/Not sure

This is the end of the questionnaire, thank you for participating.

APPENDIX F: Diet History Questionnaire II Information

A. Detailed information is available on the DHQ II in the link below:

<https://epi.grants.cancer.gov/dhq2/about/>

APPENDIX G: Anthropometric Assessment Document

NFS 210 Applied General Nutrition Anthropometric and Bone Density Measurements

Name: _____ Student ID Number: _____

Record your personal assessment information on this sheet. Keep this paper in a safe place – take a picture of it so you'll always have it!

Bone Ultrasonometer Test Results

Left/Right T-Score: _____ Left/Right Z-score (females only): _____

Anthropometric Information

Height: _____ cm

Weight: _____ kg

Waist Circumference: _____ cm

Hip Circumference: _____ cm

Conversions

2.54 cm = 1 inch
• divide cm by 2.54

2.2 kg = 1 pound
• multiply kg by 2.2

Body Fat Percentage

In Body: _____ %

Body Mass Index (BMI)

You will need to calculate this yourself before you leave the assessment room. Ask an undergrad or grad TA for help if you need it ☺

BMI: _____ kg/m²

BMI

$\frac{\text{weight (kg)}}{\text{height (m)}^2}$

or

$\frac{\text{weight (lb)} \times 703}{\text{height (in)}^2}$

APPENDIX H: InBody Results Sheet

RESULTS SHEET BREAKDOWN

SAMPLE RESULTS SHEET

This is the body composition results sheet that the InBody770 prints out. Understand each output section in the following pages.

APPENDIX I: 2015 HEI Scoring Guide

Table 1. Healthy Eating Index-2015 components, point values, and standards for scoring

Component	Maximum points	Standard for maximum score	Standard for minimum score of zero
Adequacy			
Total Fruits	5	≥ 0.8 c equivalents/1,000 kcal	No fruit
Whole Fruits	5	≥ 0.4 c equivalents/1,000 kcal	No whole fruit
Total Vegetables	5	≥ 1.1 c equivalents/1,000 kcal	No vegetables
Greens and Beans	5	≥ 0.2 c equivalents/1,000 kcal	No dark green vegetables or beans and peas
Whole Grains	10	≥ 1.5 oz equivalents/1,000 kcal	No whole grains
Dairy	10	≥ 1.3 c equivalents/1,000 kcal	No dairy
Total Protein Foods	5	≥ 2.5 oz equivalents/1,000 kcal	No protein foods
Seafood and Plant Proteins	5	≥ 0.8 c equivalents/1,000 kcal	No seafood or plant proteins
Fatty Acids	10	$(\text{PUFAs}^a + \text{MUFAs}^b) / \text{SFAs}^c \geq 2.5$	$(\text{PUFAs} + \text{MUFAs}) / \text{SFAs} \leq 1.2$
Moderation			
Refined Grains	10	≤ 1.8 oz equivalents/1,000 kcal	≥ 4.3 oz equivalents/1,000 kcal
Sodium	10	≤ 1.1 g/1,000 kcal	≥ 2.0 g/1,000 kcal
Added Sugars	10	$\leq 6.5\%$ of energy	$\geq 26\%$ of energy
Saturated Fats	10	$\leq 8\%$ of energy	$\geq 16\%$ of energy

^aPUFAs=polyunsaturated fatty acids.

^bMUFAs=monounsaturated fatty acids.

^cSFAs=saturated fatty acids.

APPENDIX J: Additional Tables

Table 5. Median Split for Magnitude of BWD – Whole Sample vs. Stratified by Sex		
Group	Mean ($\pm$ SD)	Median
Whole Sample (n=434)	10.3 (8.7)	7.97 ¹
Male (n=93)	11.3 (8.9)	9.67 ²
Female (n=341)	10.1 (8.6)	7.25 ³
<i>Abbreviations:</i> BWD- Body Weight Dissatisfaction, SD- Standard Deviation; ¹ Median used to quantify high/low BWD in whole sample ² Median used to quantify high/low BWD in males ³ Median used to quantify high/low BWD in females. Frequencies.		

Table 6. Comparison of Percent Body Fat Measurement – Bod Pod and InBody 770					
Group	%BF Measure	N	Mean (± SD)	<i>t</i>	<i>p</i>
Whole Sample (n=425)	Bod Pod	191	26.1 (8.5)	1.79	0.75
	InBody 770	234	24.7 (8.0)		
Male (n= 90)	Bod Pod	40	18.7 (9.9)	1.49	.140
	InBody 770	50	15.8 (7.9)		
Female (n= 335)	Bod Pod	151	28.1 (6.8)	1.40	.162
	InBody 770	184	27.1 (6.0)		
Abbreviations: %BF- Percent Body Fat; SD- Standard Deviation *p<0.05, **p<0.01; Significance between percent body fat measurements, Levene’s Test for Equality of Variances; Independent Samples T-Test					

Table 7. Descriptive Analysis of Main Outcomes – Whole Sample							
Variable	Group	N	Mean (±SD)	F	η _p ²	Power	p
HEI Total Score	Lower BWD	198	65.3 (10.8)	2.068	.005	.300	0.91
	Higher BWD	197	63.7 (11.2)				
BF (%)	Lower BWD	213	23.5 (6.8)	22.418	.050	.997	.000**
	Higher BWD	212	27.2 (9.0)				
MVPA (min/wk)	Lower BWD	154	339.95 (245.4)	1.115	.004	.183	.292
	Higher BWD	153	369.95 (252.4)				
Abbreviations: BWD- Body Weight Dissatisfaction, HEI- Healthy Eating Index, BF- Body Fat, measured as percent by air displacement plethysmography and bioelectrical impedance analysis, MVPA- Moderate-to-Vigorous Physical Activity, min-minutes, wk- week; *p<0.05, **p<0.01; Magnitude of Body Weight Dissatisfaction; one-way Analysis of Variance (ANOVA)							

Table 8. Between Group Comparisons for 2015 HEI Components – Whole Sample					
Variable Mean (possible score)	LBWD Mean ($\pm$ SD) (n= 198)	HBWD Mean ($\pm$ SD) (n= 197)	<i>t</i>	df	<i>p</i>
Adequacy (60)					
Total Fruits (5)	3.9 (1.4)	3.7 (1.5)	.976	393	.330
Whole Fruits (5)	4.3 (1.3)	4.0 (1.4)	1.466	393	.143
Total Vegetables (5)	4.1 (1.1)	3.8 (1.4)	2.316	393	.021*
Greens and Beans (5)	4.2 (1.4)	3.8 (1.7)	2.583	393	.010**
Whole Grains (10)	2.5 (1.4)	2.2 (1.4)	1.817	393	.070
Total Dairy (10)	5.7 (2.7)	6.1 (2.8)	-1.312	393	.190
Total Protein (5)	4.1 (1.1)	4.1 (1.3)	.691	393	.490
Seafood and Plant Protein (5)	4.2 (1.4)	3.8 (1.6)	2.256	393	.025*
Fatty Acids (10)	5.6 (3.2)	5.3 (3.2)	.870	393	.385
Moderation (40)					
Refined Grains (10)	7.5 (2.7)	7.8 (2.6)	-1.325	393	.186
Added Sugars (10)	7.7 (2.6)	7.3 (2.9)	1.693	393	.091
Saturated Fats (10)	6.4 (2.8)	6.7 (2.9)	-.888	393	.375
Sodium (10)	5.2 (2.6)	5.1 (2.9)	.365	393	.716
<i>Abbreviations:</i> SD – standard deviation, HEI - Healthy Eating Index, LBWD- Lower Body Weight Dissatisfaction, HBWD- Higher Body Weight Dissatisfaction; *p<0.05, **p<0.01; Magnitude of Body Weight Dissatisfaction; Independent Samples T-Test					

Table 9. Between Group Comparisons % BF and BMI – Whole Sample						
Variable	Lower BWD Mean ($\pm$ SD)	Higher BWD Mean ($\pm$ SD)	F	η_p^2	Power	p
BF (%) (n = 425)	23.5 (6.8)	27.2 (9.0)	22.418	.050	.997	.000**
BMI (kg/m ²) (n = 427)	21.9 (3.2)	24.6 (3.0)	76.032	.152	1.000	.000**
<i>Abbreviations:</i> BWD- Body Weight Dissatisfaction, SD – standard deviation, BMI – Body Mass Index, kg/m ² – kilograms over meters squared, BF- Body Fat, measured as percent by air displacement plethysmography and bioelectrical impedance analysis *p<0.05, **p<0.01; Magnitude of Body Weight Dissatisfaction; one-way Analysis of Variance (ANOVA)						

Table 10. Between Group Comparisons for Dietary Components – Whole Sample					
Variable	Lower BWD Mean ($\pm$ SD) (n= 198)	Higher BWD Mean ($\pm$ SD) (n= 197)	t	df	p
Calories	2025.8 (1030.2)	2020.4 (1194.4)	.048	393	.962
Total Carbohydrate (g)	252.3 (128.9)	251.1 (159.2)	.077	393	.938
Total Fat (g)	77.2 (43.9)	72.6 (42.1)	1.050	393	.294
Total Protein (g)	75.0 (43.5)	72.9 (45.5)	.489	393	.625
Total Saturated Fat (g)	24.1 (13.7)	23.3 (15.6)	.543	393	.587
Dietary Fiber (g)	21.5 (12.6)	19.1 (12.6)	1.870	393	.620
Total Sugar (g)	112.8 (67.4)	117.8 (82.9)	-.653	393	.514
Added Sugar (tsp)	13.9 (11.8)	15.5 (15.1)	-1.097	393	.273
<i>Abbreviations:</i> BWD- Body Weight Dissatisfaction, SD – standard deviation, g- grams, tsp- teaspoon *p<0.05, **p<0.01; Magnitude of Body Weight Dissatisfaction; Independent Samples T-Test					

Table 11. Between Group Comparisons for Dietary Components – Stratified by Sex					
Male					
Variable	Lower BWD Mean ($\pm$ SD) (n =43)	Higher BWD Mean ($\pm$ SD) (n= 44)	<i>t</i>	df	<i>p</i>
Calories	2250.8 (1165.0)	2758.5 (1610.0)	-1.688	85	.096
Total Carbohydrate (g)	285.7 (149.9)	338.0 (201.9)	-1.375	85	.174
Total Fat (g)	78.8 (48.5)	93.2 (59.4)	-1.240	85	.219
Total Protein (g)	89.1 (50.4)	98.4 (60.9)	-.778	85	.440
Total Saturated Fat (g)	24.7 (16.1)	31.5 (23.0)	-1.586	85	.118
Dietary Fiber (g)	23.9 (17.3)	20.7 (12.3)	1.015	85	.311
Total Sugar (g)	127.6 (72.7)	164.4 (117.6)	-1.754	85	.083
Added Sugar (tsp)	16.5 (13.4)	23.7 (22.8)	-1.792	85	.077
Female					
Variable	Lower BWD Mean ($\pm$ SD) (n= 154)	Higher BWD Mean ($\pm$ SD) (n= 154)	<i>t</i>	df	<i>p</i>
Calories	1941.3 (934.5)	1831.2 (1002.9)	.997	306	.320
Total Carbohydrate (g)	239.2 (111.9)	230.0 (143.4)	.629	306	.530
Total Fat (g)	76.1 (42.0)	67.3 (34.7)	2.000	306	.046*
Total Protein (g)	71.1 (40.6)	65.6 (37.3)	1.249	306	.212
Total Saturated Fat (g)	23.7 (12.7)	21.2 (12.2)	1.765	306	.079
Dietary Fiber (g)	20.4 (11.0)	19.0 (12.7)	1.046	306	.296
Total Sugar (g)	106.9 (58.1)	106.1 (71.2)	.116	306	.908
Added Sugar (tsp)	13.0 (9.6)	13.4 (12.5)	-.282	306	.778
BWD- Body Weight Dissatisfaction, SD – standard deviation, g- grams, tsp- teaspoon					
*p<0.05, **p<0.01; Magnitude of Body Weight Dissatisfaction; Independent Samples T-Test					

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