

## ABSTRACT

Title of Document: EFFECTS OF WEB-BASED SELF-REPORTING:  
COLLEGE STUDENTS' SELF-EFFICACY  
REGARDING FRUIT AND VEGETABLE INTAKE

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This study evaluated the effect of an online diet-tracking tool on college students' self-efficacy regarding fruit and vegetable intake. A convenience sample of students completed online self-efficacy surveys before and after a six-week intervention in which they tracked dietary intake with an online tool. Group one (n=22 fall, n=43 spring) accessed a tracking tool without nutrition tips; group two (n=20 fall, n=33 spring) accessed the tool and weekly nutrition tips. The control group (n=36 fall, n=60 spring) had access to neither. Each semester there were significant changes in self-efficacy from pre- to post-test for men and for women when experimental groups were combined ( $p < 0.05$  for all); however, these changes were inconsistent.

Qualitative data showed that participants responded well to the simplicity of the tool, the immediacy of feedback, and the customized database containing foods available on campus. Future models should improve user engagement by increasing convenience, potentially by automation.

EFFECTS OF SELF-REPORT ON STUDENTS' SELF-EFFICACY

EFFECTS OF WEB-BASED DIETARY SELF-REPORTING:  
COLLEGE STUDENTS' SELF-EFFICACY  
REGARDING FRUIT AND VEGETABLE INTAKE

by

Team DIET: Dietary Information and Evaluation Technologies

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## **Gemstone**

Gemstone is a four-year multidisciplinary undergraduate research program at the University of Maryland. The program is affiliated with the University Honors College and the A. James Clark School of Engineering. The program was founded in 1996 in order to provide undergraduate students with practical experience with the research process. Originally targeting engineering students, it has since expanded to include opportunities for all majors to explore research interests both within and outside of the students' majors.

Gemstone focuses on the development of research, teamwork, communication and leadership skills, helping students to become creative problem solvers. One of the major goals of the program is to encourage students to solve real-world problems with creative, interdisciplinary approaches, thus allowing students to explore the intersection of science, technology and society (STS) in meaningful ways. Within the program, students are first introduced to STS and research methods. These courses give students the background necessary to propose their own projects aimed at solving those world problems that are most interesting and relevant to them. At the end of the first year of the program, students propose projects and are placed on teams to tackle the proposed topics.

Throughout the next three years of the program, the students complete the research process by designing an original research study within their proposed topic, carrying out their design with the guidance of a faculty mentor, and writing and sharing their results with the larger scientific community. This paper is the result of three years of research and analysis and represents the final chapter of the program as well as the final phase of the research cycle.

## **Team DIET**

Team Dietary Information and Evaluation Technologies (DIET) is a senior team in the Gemstone program. The team includes majors from many different departments including, but not limited to: romance languages, history, psychology, criminology, operations management, information systems, mechanical engineering, aerospace engineering, electrical engineering, bioengineering, and physiology and neurobiology. In spite of this wide range of interests, we have come together because of a shared passion for technology, food, and nutrition education.

The project proposed aimed at providing students with improved access to nutrition information. Using information from the University Dining Hall, the team originally planned to implement an intervention in which students' purchases were automatically logged and analyzed. The idea was to see if automatic access to personalized information, without the need to self-report, influenced students' nutritional self-efficacy. A timeline of the project can be found in Appendix A.

While technological difficulties prevented this initial vision, our study remained constant in its goal to explore the effect of improved access to nutritional information. Our goal was to fill a need we found from our own experiences within the dining halls. While nutrition information was readily available on the Internet, it was sometimes difficult to find and confusing to read. We sought to meet this need by creating a personalized, user-friendly interface that allowed students to more easily track the foods they consumed on a daily basis. After nearly four years of development, implementation, and analysis we are happy to say that we have succeeded in creating such a tool. Our website caters to the individual student and allows students to search and log foods more

easily. Now open to the entire student body, we are proud to leave behind a tool that students can use even after we have left campus.

Ultimately, our passion for nutrition education has inspired us to seek to use the Internet to improve students' knowledge about their own habits. We are excited by the fact that the DIET Tracker allows students to access information that could impact their lives for the better.

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## The Effect of Web-Based Dietary Self-Reporting on College Students' Self-Efficacy Regarding Fruit and Vegetable Intake

One of the most significant health issues in modern America is obesity (Mokdad et al., 1999). 35.7% of U.S. adults and almost 17% of youth were classified as obese between 2009 and 2011, and obesity is the second leading cause of preventable death in America (Center for Disease Control, 2011; Ogden, Carroll, Kit, & Flegal, 2012; Wardlaw & Smith, 2011). College students are at especially high risk of weight gain and obesity because time constraints, inconsistent schedules, and the high availability of fast food options make maintaining a balanced diet difficult (Haberman & Luffey, 1998). Because poor diets have been linked to chronic diseases such as cardiovascular disease, hypertension, diabetes, cancer, and osteoporosis, college students have cause for concern (Wardlaw & Smith, 2011). In fact, it has been shown that most students gain weight in their first year in college (Delinsky & Wilson, 2008). One study found that 74% of the students who participated in the study gained some weight during their freshman year of college, and 33% gained at least five pounds; this result has been confirmed by other research as well (D. A. Anderson, Shapiro, & Lundgren, 2003; Delinsky & Wilson, 2008).

The weight gain that most students experience in college can be partially attributed to poor eating habits, including excessive intake of fatty foods and alcohol (Jackson, Berry, & Kennedy, 2009; Lowe et al., 2006). The United States Department of Agriculture (USDA) and the Department of Health and Human Services (DHH) recommend a diet that is high in fruits, vegetables, whole grains, and low fat dairy products according to its Report of the Dietary Guidelines Advisory Committee on the

Dietary Guidelines for Americans (2010). In addition, USDA and DHH suggest diets low in saturated fat, sodium, and calories that come from solid fats and added sugars; however, studies have shown that college students, among others, usually do not eat according to these recommendations (Haberman & Luffey, 1998; Jackson et al., 2009; Lowry et al., 2000). In a survey of 4,838 students from 136 colleges and universities, only 26% of students reported eating the recommended five or more servings of fruits and vegetables (Lowry et al., 2000). As there are about 21 million students attending universities in the United States, the study would suggest that as many as 15 million of these students may be lacking important nutrients found in fruits and vegetables (Snyder & Dillow, 2011).

Students often eat poorly because they are unaware of what constitutes a healthy diet, they do not know the importance of good eating habits, or they do not believe that they are capable of making healthy decisions. For example, Lowry et al. (2000) found that both female and male students associated vigorous physical activity with weight loss but ignored the effect of fruit and vegetable consumption. In addition, only one in three respondents reported receiving guidance on dietary behavior and nutrition from their college. When students have difficulty accessing nutritional information, it can lead to ignorance and lower self-efficacy, which makes it more difficult to maintain a healthy diet (Deshpande, Basil, & Basil, 2009).

Our study sought to address the dietary behaviors of college students, specifically their consumption of fruits and vegetables. We measured the effect of an online nutrition intervention on student self-efficacy by comparing pre- and post-test scores on a self-efficacy scale. We created a website that participants could access to report their intake

and view their dietary history. Our experiment addressed the question: is there a relationship between use of a web-based dietary intake tracking tool and the self-efficacy of students? Based on the results of other intervention-based self-efficacy studies, we hypothesized that there would be a significant positive correlation between use of a web-based diet tracking tool and student self-efficacy (E. S. Anderson, Winett, & Wojcik, 2007; E. S. Anderson, Winett, Wojcik, Winett, & Bowden, 2001; Poddar, Hosig, Anderson, Nickols-Richardson, & Duncan, 2010).

## Literature Review

This analysis of the scientific literature serves as both the context and the rationale for the Diet Tracker project. First, we describe the obesity epidemic in the United States and analyze its causes and consequences. Then we describe the importance of a healthy lifestyle, emphasizing fruit and vegetable consumption. In addition, we explain why adolescence is a critical habit-forming period in which a healthy diet has beneficial long-term consequences.

Next, we look specifically at the diet of college students. We include studies that describe the most frequent flaws in the college diet and their health effects. Additional studies characterize the many factors that influence students' dietary choices and explain why college is an especially difficult environment for maintaining a healthy diet. Finally, we discuss the lack of nutritional awareness among college students, and suggest that better access to information would help students improve their eating habits.

Another major area of our research identified the motivations that affect human behavior, including self-efficacy. Our review defines this term and explains how this quantifiable variable is associated with a person's actions, including dietary choices. We show that a dietary intervention can improve self-efficacy, but we also show why this factor is difficult to change.

In order to design our intervention, we looked at other examples of internet-based self-reporting platforms and used them to speculate how such a program could affect users' self-efficacy. To improve our design, we researched how the program should work, how it should look in order to appear credible, how it should be programmed considering

our need for speed and engagement, and how it should be arranged so that the content was consistent, organized, and clear.

Since our investigation relied on users' self-report of their dietary intake and self-efficacy, we also discuss the validity of this type of data reporting. We facilitated accurate reporting by compiling a reliable and intuitive database of nutritional data.

We found evidence that a web-based reporting system would have major advantages over traditional methods such as diet histories. As expected from published results, we still encountered problems with attrition. We searched for ways to ensure an adequate level of retention, and we found that ensuring ease of use, providing incentives, and sending regular e-mail reminders were ways to minimize attrition (Cotter, Burke, Loeber, Mutchka, 2005).

### **The Importance of Healthy Eating**

Eating healthily is a positive behavior that has many benefits including protection from obesity and the array of health problems associated with this disease. According to the National Center for Health Statistics, approximately 17% of adolescents and 35.7 percent of adults are obese, and many more are overweight (Ogden et al., 2012). Weight is not the only factor in measuring dietary health; people who make poor dietary choices are at risk of developing health problems even if they are not overweight (Haberman & Luffey, 1998). The Dietary Guidelines (2010) warn that everyday choices, particularly amount of macronutrient intake, have a critical effect on the risk of developing adult-onset diabetes and cardiovascular diseases including atherosclerosis and hypertension. Cardiovascular diseases can lead to heart attack and stroke, which are leading causes of death in the United States (Dietary Guidelines Advisory Committee, 2010).

Moderate positive changes to diet and physical activity can lead to many health benefits including improved self-esteem, higher resistance to illness, better academic performance, healthier weight, and reduced risk of life-threatening cardiovascular disease (Behrman, 1996; Dietary Guidelines Advisory Committee, 2010; S. Richards, 2009). Making these changes can help prevent and treat obesity (Wardlaw & Smith, 2011). Specifically, the average American needs to consume more fruits, vegetables, and whole grains and reduce intake of sugar and solid fats (Dietary Guidelines Advisory Committee, 2010). In fact, the Office of Disease Prevention and Health Promotion estimated in 2000 that “only 28% of persons over the age of two are meeting daily recommendations for fruit intake and even fewer (3%) are meeting daily recommendations for vegetable intake” (Boyle & LaRose, 2009). This is particularly alarming when one considers all of the benefits of eating fruits and vegetables. The various nutrients and phytochemicals such as fiber, minerals, folate, vitamin B6, vitamin B12, vitamin E, vitamin C, flavonoids, and phytoestrogens that can be found in fruits and vegetables have been shown to greatly reduce the risk of coronary heart disease (Tucker, 2004).

We chose to focus on fruit and vegetable consumption for our study because there is a growing body of research demonstrating the positive effects of fruits and vegetables on human health. Fruits and vegetables contain many of the essential vitamins and minerals, as well as fiber, that can help boost the immune system and reduce the likelihood of catching illness (Center for Disease Control, 2011). Some of these key nutrients include fiber, folate, potassium, vitamin A, and vitamin C (Center for Disease Control, 2011). According to the USDA and DHH, eating a diet rich in fruits and vegetables may reduce the risk of numerous diseases including cardiovascular disease,

type 2 diabetes, and some forms of cancer directly related to the digestive system, such as mouth, stomach, and colon cancer. In addition, eating fruits and vegetables rich in potassium may be linked to reduced bone loss and the prevention of kidney stones (Dietary Guidelines Advisory Committee, 2010). Experts agree that in order to improve the American diet and curb the rate of obesity it is essential to encourage healthy eating in young people (Behrman, 1996; Dietary Guidelines Advisory Committee, 2010; Wardlaw & Smith, 2011). Adolescence is a key period for the formation of life-long health behaviors (D. A. Anderson et al., 2003; Wardlaw & Smith, 2011). Thus, it is advantageous to establish healthy eating habits early in life. Furthermore, studies have linked a healthy diet with success in school and a poor diet with substandard academic performance (Behrman, 1996; Kobayashi, 2009). These positive effects of good nutrition, along with the direct health benefits, demonstrate that it is critical to improve one's eating habits as early as possible.

### **Nutritional Studies of College Students**

College students face serious obstacles to maintaining proper health and nutrition, often leading to issues with their weight. The American College Health Association (2012) estimates that roughly 35% of American college students are overweight. It has also been shown that people between the ages of 18 and 29 are the group most likely to show increases in weight, emphasizing that college students are at high risk for weight gain (Racette, Deusinger, Strube, Highstein, & Deusinger, 2005). Factors such as a busy lifestyle, focusing on coursework, and the limited availability of dietary choices make it difficult for students to maintain a healthy diet in a college setting. In fact, a study by Serlachius, Hamer, & Wardle (2007) specifically linked weight gain to “students who

experience stress due to the workload of attending university.” Another study observed students who cook their own meals and examined their ability to consume a healthy diet (Eves, Kipps, & Parlett, 1995). This study was conducted on first-year students who were asked to complete a seven-day weighed food record to examine the sufficiency of their diets as a part of a college course in nutrition (Eves, Kipps, & Parlett, 1995). The results showed that students who were responsible for cooking their own food generally ate the recommended dietary amounts, as well as eating a similar diet to young adults who were not students (Eves, Kipps, & Parlett, 1995). These results imply that there is a desire among college students to eat properly, and that universities should take steps to help students eat more nutritious diets.

Another study examined the relationship between students’ weights and factors including diet, physical activity, environment, and personal attitudes. It was found that over half of the overweight students were not even aware that they were overweight (Boyle & LaRose, 2009). This ignorance could help to explain why so many students have poor eating habits. More encouraging, however, is the finding that having greater confidence in the ability to eat healthily and exercise was correlated with improved eating and increased physical activity (Boyle & LaRose, 2009). These findings suggest that providing students with the accurate nutrition education can lead to greater awareness and improvement.

Other nutrition studies have specifically investigated consumption of fruits and vegetables among college students. DeBate, Topping, and Sargent (2001) found that like other Americans, most college students do not consume enough fruits and vegetables but over-satisfy their daily meat requirement. This study used a questionnaire that assessed



nutritional intake, weight status, and dietary practices of college students. Among these college students, only 18% consumed the daily recommendations for fruits and vegetables (DeBate et al., 2001). The study also found that the three most common negative dietary habits among college students are meal skipping – particularly breakfast, frequent and regular consumption of fast foods, and consistent failure to meet the recommended intake of all food groups (DeBate et al., 2001). Ha and Caine-Bish (2009) found that fruit and vegetable consumption among college students was below the recommended nine servings; the students consumed only 2.1 to 5.5 servings of fruits and vegetables combined. Kelly, Mazzeo, and Bean (2013) found that the typical college student consumes only 1 serving of fruit and 1.5 servings of vegetables daily. These studies show that the average college student's diet is drastically below dietary recommendations.

One study examining the eating practices of students used dietary records in an effort to improve health education programs and nutrition. The researchers found that the diet of young adults in college could be improved by increasing intake of fruits and vegetables and decreasing intake of carbonated beverages and high-fat dishes (Huang, Song, Schemmel, & Hoerr, 1994). In another study, data were analyzed from the 1995 National College Health Risk Behavior Survey for undergraduate students in order to determine how knowledgeable these college students were about nutrition (Lowry et al., 2000). Only one in three students reported that their university informed them about this issue; furthermore, few students connected the consumption of more fruits and vegetables with managing their weight, which suggests some gaps in their nutritional knowledge (Lowry et al., 2000). These studies found that there is a lack of nutritional awareness in

the college environment, specifically regarding the consumption of fruits and vegetables, which is precisely what our intervention was designed to address.

A longitudinal study on dietary change from adolescence to adulthood identified six factors that influenced this change: parents, partners, children, nutritional awareness, employment, and lack of time. The respondents who cited nutritional awareness as an influence on their dietary change showed a significantly greater increase in their intake of fruits and vegetables compared to respondents who did not cite this as a cause (Lake et al., 2004). College students' diets can be improved by filling the gaps in their understanding of nutrition and educating them about the importance of this issue. One survey found that the majority of students would like to receive health information through an online source, and nearly 75% of the students reported that they had previously searched for health information online through different search engines and websites (Escoffery et al., 2005). These students reported that website credibility was a crucial consideration in their search for information (Escoffery et al., 2005).

Gender differences are another factor that may play a role in the variation of dietary attitudes and practices. Davy, Benes and Driskell (2006) found that there were significant gender differences in college students' heights and weights, nutrition information, and nutrition self-assessments and beliefs, but not in dietary choices or where and with whom the students ate. Female students tended to get more nutrition knowledge from family members and magazines (Davy et al., 2006). In addition, women were more likely than men to believe that they ate too much sugar and that limiting carbohydrate and fat intake is important in order to lose weight (Davy et al., 2006). A study by Morse and Driskell (2009) investigated some similar trends in gender

differences associated with college students' fast food preferences. The study found that there were no significant differences between men and women in the students' eating practices. However, Morse and Driskell did also find that women were significantly more likely to get nutrition information from friends and magazines. Additionally, women were more likely to agree that the nutritional value of food is important to them (Morse & Driskell, 2009). Both studies had similar distributions of male and female respondents, with about 65% of the participants being female and 35% being male (Davy et al., 2006; Morse & Driskell, 2009). This research suggests that significant gender differences exist in college students' attitudes toward nutrition, although not necessarily in their dietary choices and eating practices.

### **The Theory of Planned Behavior**

In order to positively influence the everyday dietary choices of college students, we must first understand what factors affect their behavior. According to the Theory of Planned Behavior, the three main determinants of human action are (1) the consequences expected from the behavior, (2) the perception of social pressure regarding the behavior, and (3) the evaluation of the effort required to adopt the behavior (Pawlak, Malinauskas, & Rivera, 2009). Therefore, by informing students of the consequences of their dietary choices, making use of the already present social pressure to maintain balanced nutritional intake, and providing an easy way to implement healthy dietary changes, we will have addressed each of the respective foundations for planned behavior and increased the chance of effecting a lasting positive change (Pawlak, Malinauskas, & Rivera, 2009). Other behavioral research has shown that the most important influences on students' everyday dietary choices are taste, time, convenience, and budget, in that order

(Huang et al., 1994). Concern for personal health becomes a significant factor once one is informed about the risks of poor nutrition (Deshpande et al., 2009). Studies show that the more informed students are about the nutritional content of their food, the healthier their food choices will be (Butler, Black, Blue, & Gretebeck, 2004; Cousineau, Franko, Ciccazzo, Goldstein, & Rosenthal, 2006; Ha, Caine-Bish, Holloman, & Lowry-Gordon, 2009; Hawks, Madanat, Smith, & De La Cruz, 2008; Kolodinsky, Green, Michahelles, & Harvey-Berino, 2008; Peterson, Duncan, Null, Roth, & Gill, 2010).

### **Self-Efficacy**

Another key component to dietary change is self-efficacy, a person's belief that he or she has the ability to behave in a desired way (Bandura, 1997). Self-efficacy can be affected by social persuasion, whether in the form of peer pressure or encouragement from authority figures. However, it is much easier to decrease a person's self-efficacy than to increase it because someone with high self-efficacy will attribute a success to their abilities and failure to bad luck, whereas a person with low self-efficacy is more likely to attribute success to good luck and failure to lack of ability (Gist & Mitchell, 1992). Self-efficacy has been shown to be influenced by personal experiences of success and failure, as well as observing the successes and failures of others. It has also been shown to have significant correlation with behavioral change, accounting for up to 59% of the variance in fruit and vegetable consumption in several studies (E. S. Anderson et al., 2007; E. S. Anderson et al., 2001; Luszczynska, Scholz, & Schwarzer, 2005). When combined with a high expectancy value, or the idea that an outcome is valuable and positive, self-efficacy is highly indicative of future action. Increasing self-efficacy, the primary factor for influencing behavior, should cause participants to make positive

changes to their diets (E. S. Anderson et al., 2007; Luszczynska , Scholz, & Schwarzer et al., 2005).

One study by Richert et al. (2010) examined the role of planning, intentions, and self-efficacy on dietary behavior. A survey of 411 participants measured their intentions of eating fruits and vegetables, planning efforts to do so, self-efficacy of eating fruits and vegetables, and fruit and vegetable intake at the beginning and end of a four-week period. Self-efficacy was found to be the best predictor of future behavior, while having intentions did not have a direct effect on behavior. This study demonstrates the importance of self-efficacy; even if people have plans to achieve a goal, it is difficult to carry out those plans without self-efficacy.

A study by Anderson et al. (2007) created a 15-week intervention, in which participants were shown a weekly 5-6 minute video. This weekly video significantly increased viewers' self-efficacy as measured by the Self-Efficacy for Increasing Fiber and Fruits and Vegetables scale. This scale asked physical, social, and self-evaluative questions on a rating scale. It also inquired about expected outcomes of behavioral change, such as health or appetite satisfaction changes. Due to the fact that self-efficacy measurements have been shown to be universal among different cultures and nationalities, self-efficacy is a valid tool to use in a diverse population such as the student population at the University of Maryland. For that reason, it should not be significantly affected by demographic differences between participants (Luszczynska et al., 2005).

### **Website Development**

Providing students with nutritional information is critical to dietary change, but choosing the most effective distribution channel is equally important. As opposed to

traditional diet intervention methods such as written personal food records or nutritional information distributed by universities, the internet is convenient to use, can be updated in real-time, and is capable of reaching a broad audience, especially within the college student demographic. For this reason, we chose to design a web application. The first step in the design process was to decide which programming language and methodology to use. Three of the most widely used platforms are J2EE, .NET, and Ruby on Rails, according to Stella, Jarzabek, and Wadhwa (2008). A study they conducted tested the ease of maintenance of these three platforms in four areas: modifiability, testability, understandability, and portability. It rated Ruby on Rails as having the best performance. Also, researchers in the University of Maryland's Computer Science Department have outlined several methods of analyzing and safeguarding against security vulnerabilities of applications developed with Ruby on Rails (Chaudhuri & Foster, 2010). We took advantage of the information that is readily available for our own development plans.

Studies have identified four key features that must be considered in order to appeal to potential users: (1) personalized and tailored information, (2) adequate reading level, (3) credibility, and (4) aesthetic appeal (De Angeli, Sutcliffe, & Hartmann, 2006; B.J. Fogg, Marshall, Laraki et al., 2001; B. J. Fogg, Marshall, Kameda et al., 2001). A survey revealed that many college students are most interested in web nutrition programs that target their unique needs (Alexander et al., 2010). Neuhauser, Rothschild, and Rodríguez (2007) examined the reasons people avoided using USDA's MyPyramid online dietary tracker despite the website's valuable nutritional information. They used various literacy tests to assess the usability of the site and found that the reading level of MyPyramid was ranked well above the national average reading level (Neuhauser,

Rothschild, & Rodríguez et al., 2007). Based on the above findings, we have designed a website with a visually appealing, simple user interface and functionality tailored to student needs, which is a reason our tool is unique.

For our site to be successful, we needed to gain users' trust by establishing credibility with our participants. A quantitative study of over 1400 people at Stanford University identified several important factors to help increase perception of a website's credibility. Those factors include responding quickly to customer service requests, listing contact information, allowing users to search previous content, and providing links to reputable websites (B.J. Fogg, Marshall, Laraki et al., 2001; B. J. Fogg, Marshall, Kameda et al., 2001). According to De Angeli, Sutcliffe, and Hartmann (2006), design features and interaction styles are also critical to a website's success. The results from their study showed that between two websites with identical content, users gave higher ratings to the site with more aesthetic appeal, citing descriptors such as pleasantness, clarity, neatness, symmetry, creativity, originality, sophistication, attractiveness, and use of special effects (De Angeli, Sutcliffe, & Hartmann et al., 2006). We used these results as guidelines while designing our own website.

Additionally, studies have shown that web-based interventions are effective with college students (Normand & Osborne, 2010; Poddar et al., 2010). One study found that a five week online intervention involving emails and posted information increased students' use of self-regulation strategies and self-efficacy for consuming three servings of dairy products a day. However, the researchers found that this intervention was not successful in improving students' outcome expectations or actual intake (Poddar et al., 2010). The results of this study suggest that web-based interventions can be effective in

increasing college students' self-efficacy, although these improvements may or may not necessarily impact intake. However, not all studies showed a change in behavior and self-efficacy. Normand and Osborne (2010) found that a nutrition intervention that gave participants individualized dietary feedback improved students' food selection behavior within the university's dining halls. Throughout the duration of the study, participants placed their food receipts and a checklist of the foods eaten into a drop box in the dining hall. They then checked their email daily for nutrition information and personalized feedback in the forms of graphs and calorie totals put together by the researchers based on the students' intake the previous day (Normand & Osborne, 2010). This study suggests that email is an effective way to distribute personalized nutrition information and that access to this information can result in a reduction of calories and fat intake.

Another study by Woodall et al. (2007) looked at the effects of using email notifications to inform participants of updates on a nutrition website. Nearly half of the 755 adult participants in the study received emails once every five weeks with links to new information and updates on the site. The site found that a total of 23.5% of the participants responded to at least one email, and 51.2% of these participants responded to half of the email messages by logging on to the website. In addition, website traffic increased significantly on days that email notifications were sent compared to all other days. The study concluded that email messages tend to promote a short-term increase in website activity for a nutrition information website and are therefore a good way of encouraging participants to continue using the website. Based on these results, we decided to also test the effectiveness of email use in part of our study.

## LITERATURE REVIEW



## **Website Usability**

In order to make our website more efficient and attractive to users, it was important to adapt the website to be responsive to users' needs. A website that is highly usable is attractive and promotes activity among site visitors (Palmer, 2002). Studies identify five main themes of website usability: accessibility, identity, navigation, content, and credibility (Meyers, 2012; Palmer, 2002). An accessible website is easy to use, has main menus, clear and concise navigation labels and consistent and easily identifiable content and links. It should include a clear link to an "About Us" page, a link back to site's index on every page, contact information and an easy-to-use search function. Content is also key, and clear and descriptive headings should be present, critical content should be located at the top, and everything on the page should have a purpose (Meyers, 2012).

A study by Sutherland, Wildemuth, Campbell, and Haines (2005) sampled 110 nutritional websites and found that more accessible websites tended to be more aesthetically pleasing and easier to use but were more prone to displaying false information. In contrast, websites that were located through a government web portal were less accessible, more difficult to understand, and less usable even though they displayed more accurate nutrition information (Sutherland, Wildemuth, Campbell, & Haines et al., 2005). This study showed a clear conflict between sites that are easily accessible and usable with those that are accurate in their information (Sutherland, Wildemuth, Campbell, & Haines, 2005).

A study done by Palmer (2002) found that speed, good navigability, higher interactivity, more responsiveness, and higher content quality were associated with

greater perceived success by users. This indicated that the time that it takes to load the website must be reasonable, there should be clear paths to the content that users are interested in, the information provided should be customized for each user, and users should have the opportunity to give feedback (Meyers, 2012; Palmer, 2002).

### **Validity of Self-Report**

Our intervention involved collecting our participants' self-reported height and weight data in order to calculate BMI. Self-reported data are subject to social desirability bias as well as response sets, which may cause underreporting (Herbert, Clemow, Pbert, Ockene, & Ockene, 1995). Underreporting may be a result of social desirability, the inconvenience of recording everything, or simply forgetting what one consumed (Ann Yon, Johnson, Harvey-Berino, & Gold, 2006). These biases are not distributed evenly among the population, as several studies have shown that data reported by women are less accurate than data reported by men (Gorber, Tremblay, Moher, & Gorber, 2007; Herbert et al., 1995; Rimm et al., 1990; Spencer, Appleby, Davey, & Key, 2002). Men and women also differed in the type of data that was misreported. For example, in a methodological study testing the validity of self-reported height and weight as an indicator of nutritional status, researchers found that men were more likely to overestimate height while women were more likely to underestimate weight, resulting in the BMI misclassification of about 23% of men and 18% of women (Spencer et al., 2002).

During our study, our participants had the ability to self-report their food intake as part of our intervention and these data were used to create the personalized analysis available on the website. Studies have found that people tend to underreport their caloric

intake (Nataranjan et al., 2006). A study conducted by the Women's Healthy Eating and Living Study Group found that the validity of food frequency questionnaires in the reporting of fruit and vegetable consumption was 0.39 and the validity of the 24-hour recall of fruit and vegetable consumption was 0.44 (Nataranjan et al., 2006). While these numbers indicate only a modest correlation, self-reporting is often the only option open to researchers studying food intake. Additionally, research has shown that for the purpose of epidemiological studies, self-reported measures can be accurate enough to allow researchers to draw valid conclusions (Spencer et al., 2002). Our study did not analyze the validity or accuracy of any of our participants' self-reported caloric intake. Even so, participants were able to view their own self-reported data. The accuracy of the analysis on the website is dependent on the accuracy of our participants' self-reported data. Despite some inherent inaccuracies, self-reporting has been shown to be a valid measure of dietary intake (Spencer et al., 2002). Therefore, our website's personal analysis should provide reasonable information to our participants.

Studies have shown that there are many benefits of using Internet-based tools. For example, web-based programs are more cost efficient, convenient, accessible, effective, able to accommodate low-literacy populations, and private, allowing participants to maintain anonymity while participating in a familiar and emotionally safe environment (Arab, Wesseling-Perry, Jardack, Henry, & Winter, 2010; Hagler, Norman, Radick, Calfas, & Sallis, 2005; Jones et al., 2008; Thompson, Subar, Loria, Reedy, & Baranowski, 2010). Web-based self-report simplifies the process of collecting anthropometric data by eliminating the need for personal interviews (Arab et al., 2010). Dietary assessments administered via telephone or face-to-face interviews can be time-

consuming and costly for both the participants and researchers (Arab et al., 2010; Fridrici, Lohaus, & Glaß, 2009). Radvan, Wiggers, and Hazell (2004) found that self-assessments in computer-based health information programs are equal to, if not higher than, written or oral self-reports in validity. Hagler, Norman, Radick, Calfas, and Sallis (2005) investigated the comparability and reliability of computer and paper-based measures of various psychosocial constructs, such as change strategies, self-efficacy, and family influences, for fruit, vegetable, and dietary fat intake. The study found that both modes of administration yielded similar results, but computer-based measures had higher internal consistencies and slightly better reliability than paper-based surveys (Hagler et al., 2005). Similarly, in a study that tested the repeatability and validity of a computerized dietary assessment and a face-to-face interview, Probst, Faraji, Batterham, Steel, and Tapsell (2008) found that participants reported more of their dietary information on the website than those in the face-to-face interview.

Crutzen and Göritz (2010) found that social desirability was not associated with self-reported health risk behaviors in web-based research. While underreporting of undesirable behaviors can still occur with the web-based questionnaires, more socially undesirable attitudes and behaviors were underreported in face-to-face interviews (Crutzen & Göritz, 2010). Researchers have also found that there is an increase in reporting sensitive information in web-based questionnaires, and web-based self-reports of undesirable behaviors are more accurate because the online setting increases the participants' perception of privacy. Participants may feel greater comfort being assessed in their own home, they are likely to feel less judged, and they may not feel as much

shame as they would if a face-to-face interviewer was present (Arab et al., 2010; Crutzen & Göritz, 2010; Y. Probst, Tapsell, & Batterham, 2008).

While there are many advantages of web-based self-reporting, there are also several disadvantages. Many researchers of online studies have had difficulty motivating individuals to return to a website to report intake on a regular basis (Arab et al., 2010; Fridrici et al., 2009; Jones et al., 2008). Participants can control when, how long, and how often they go on a website, should they choose to log on at all. There are few, if any, consequences for participants when they stop participating in or drop out of an online study, so many studies that deal with online health issues suffer from low retention rates or imperfect completion of the program or report (Fridrici et al., 2009; Jones et al., 2008). Fridrici et al. (2009) addressed this issue in a study that examined the effects of incentives on a web-based stress prevention program. The researchers found that participants in the experimental group – those that received incentives – completed more lessons, had a significantly higher program completion rate, and had higher rates of full retention than the control group, who did not receive incentives. Additionally, participants who received incentives self-reported more accurately. Arab et al. (2010) expected a low retention rate for a validation study of a 24-hour food recall, but this was not the case. Instead participants experienced “reporting fatigue,” in which each participant had lower caloric reports as the number of days of the study increased. However, Arab et al. (2010) found that subjects’ perceived burden was minimal and 92% of participants were willing to complete a food recall two months after the final clinic visit .

Overall, researchers encourage the use of online self-reporting and hold that web-based self-reporting is as accurate, if not more accurate, than self-reporting that is done in person or on paper; in addition, it is more efficient and minimizes the costs and inconveniences of assessing diets (Arab et al., 2010; Crutzen & Göritz, 2010; Jones et al., 2008; Probst et al., 2008; Radvan et al., 2004; Thompson et al., 2010).

### **Attrition and Retention**

Often, attrition can compromise the validity and integrity of studies in which data are collected from participants over several points in time. There is a direct correlation between the effort required to retain participants and the length of a study (Cotter et al., 2005). Selective attrition, in which there are commonalities among participants that drop out, will also yield biased results (Boys et al., 2003). There is a consensus that losing contact with 30% of the original sample is unacceptable and will not yield reliable results (Boys et al., 2003; Cotter et al., 2005).

Some researchers have found that online studies are vulnerable to high attrition rates (Fridrici et al., 2009; Khadjesari et al., 2011). Conversely, a study by Richardson et al. (2010) found that being a part of an online community for an Internet-mediated walking program improved participant retention. However, the use of online communities did not improve health behaviors, but attrition was reduced due to the social support from fellow participants.

The use of incentives can increase response rates for surveys, and incentives such as gift vouchers or raffle participation can increase response rates for online surveys (Khadjesari et al., 2011). Raffles in particular are more economical and feasible than providing rewards for all participants, while still encouraging a high retention rate

(Fridrici et al., 2009). In the long run, providing incentives is more cost-effective than tracking down larger numbers of those that do not respond (Boys et al., 2003; Khadjesari et al., 2011). Moreover, extra effort and persistence to retain difficult participants was minimal compared to initial costs to fund the study. Other cost-efficient strategies that have been helpful for retaining participants include sending out personalized letters and telephoning respondents. Boys et al. (2003) found that doing so helped to maintain the rapport established at the start of the survey.

To minimize respondent attrition in a longitudinal research study of adolescent drinking, Boys et al. (2003) found that self-completion questionnaires must be kept simple and should be designed for the lowest present comprehension and literacy skill level. In the study, individuals who were academically weaker found the self-completion format to be more challenging and were less likely to continue the study, which is an example of selective attrition. With online self-completion questionnaires, respondents are unable to ask clarifying questions if they do not understand something, and there is a greater risk that respondents will lose concentration or motivation and may not answer all of the questions. Thus, the questionnaire should be written so that all potential respondents can easily and quickly understand what is being asked and how to answer it (Boys et al., 2003).

Overall, it is important to have well-planned methods of retaining participants, which will help minimize problems during follow-up. While there is no one strategy responsible for high retention, because different strategies work well with different people, Cotter et al. (2005) found that the main reason participants are lost in longitudinal studies is because not enough efforts were made to retain them.

## LITERATURE REVIEW

## **Methodology**

### **Research Design**

Our team used a quasi-experimental pre-test-post-test research design to investigate whether there is a relationship between access to an online diet intervention tool and students' self-efficacy for eating fruits and vegetables. The dependent variable was the self-efficacy of the participants. The independent variable was their access to or exclusion from our online tool known as the DIET Tracker.

Our research consisted of two independent studies, one taking place in the fall semester of 2011 and the other in the spring semester of 2012. The Fall 2011 study tested what effect the DIET Tracker and weekly nutritional email tips had on our participants' self-efficacy towards fruits and vegetables. In addition to looking at the items examined in the Fall 2011 study, the Spring 2012 study examined what effect letting participants choose how often they received nutritional email tips had on their self-efficacy towards consuming fruits and vegetables. The recruitment method and website intervention also varied between the Fall and the Spring, which is why we elected to have two separate studies.

Our population consisted of a convenience sample of University of Maryland students. Our study excluded students on special or therapeutic diets, students with severe food allergies, students without a meal plan, and students who scored higher than 19 points on the Eating Attitudes Test (EAT-26). A score of 19 points or higher indicates a strong risk of an eating disorder. The EAT-26 is a free resource we reproduced with permission from the creator (Garner, Olmsted, Bohr, & Garfinkel, 1982). It is an effective tool for screening for eating disorders but cannot substitute for a clinical diagnosis made by a qualified professional. For this reason, we provided all students who reached a score

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of 19 points or higher with information about the Eating Disorder Nutrition Counseling service provided by the University of Maryland Health Center. This follows our informed consent form found in Appendix B. The full EAT-26 test administered to our participants during our research can be found in Appendix C.

Our research consisted of two distinct groups of participants: one for our study in the fall of 2011 and one for our study in the spring of 2012. Each study's participants were divided into three subgroups: one control group, and two experimental groups. For both studies, the control group had no access to the DIET Tracker or any nutritional email tips. In the Fall 2011 study, experimental group one could access the DIET Tracker but did not receive weekly nutritional email tips. Experimental group two for the Fall 2011 study had access to the DIET Tracker and weekly nutritional email tips. In the Spring 2012 study, participants in experimental group one only had access to the DIET Tracker. Experimental group two in the Spring 2012 study had access to the DIET Tracker, received weekly nutritional email tips, and could control how frequently they received email reminders to track their diets. These emails could be set for daily or weekly reminders.

## **Procedure**

**Overview.** We conducted two studies, one in the fall of 2011 and one in the spring of 2012. After recruitment in each study, all participants were required to complete an online pre-test survey, which contained Henry, Reimer, Smith, and Reicks's (2006) self-efficacy test concerning belief in the participants' ability to eat fruits and vegetables in a variety of situations. At this point, the intervention began, and participants in the experimental groups were free to use the DIET Tracker as often as they chose. For both

the Fall 2011 and Spring 2012 studies, the intervention lasted for 6 weeks. The intervention was strategically planned to take place mid-semester to allow participants to adjust to college life and eating at the diner and to avoid holidays and exams, when participants' eating habits may change. Finally, at the completion of the intervention participants were sent a post-test survey containing the same self-efficacy test. Scores for participants were collected at the end of the study in order to gauge their change in self-efficacy.

**Institutional Review Board (IRB) approval.** Prior to starting our Fall 2011 study, we sought the IRB's approval to work with human participants. We included our informed consent form, flyers for our study, recruitment scripts, and nutrition tip email messages in our application. All of these items can be found in Appendix B and D, respectively. Throughout our research, it was necessary to resubmit our IRB application whenever we made changes to any part of our intervention or whenever our approval expired.

**Participant recruitment.** For each respective study, participant recruitment took place during the first four weeks of the Fall 2011 and Spring 2012 semesters. We recruited participants using various outlets including university email listservs, recruitment flyers, in-person recruiting at tables set up near the dining halls, university introductory classes, and Facebook. A flowchart with the total number of participants throughout the recruitment process is included in Appendix E.

Methods of recruitment for the Fall 2011 and Spring 2012 studies differed slightly. For the Fall 2011 study, we recruited most participants near the dining halls. At the time of recruitment, participants were shown how to access and use the DIET

Tracker, and their user accounts were created on-site. They were then sent our online pre-test survey at a later time. All participants recruited using this method were randomly assigned to one of the two experimental groups. Members of the control group were recruited through email listservs and Facebook. Control group members were immediately directed to our online pre-test survey and were not shown the DIET Tracker at all.

For the Spring 2012 study, most participants were also recruited near the dining halls, but only names and emails were collected at the time of recruitment. Potential participants were later emailed with a link to the pre-test survey. The individuals that completed this pre-test survey were randomly assigned into three groups: the control group, or one of two experimental groups. Groups were assigned after recruitment in order to ensure a more even distribution of participants in each group. If a participant was selected to be a part of an experimental group, that participant received an email explaining how to access his or her DIET Tracker account, which had been created for that user by our team. This method of recruitment was easier and less time-consuming. Participants only needed to give us their name and email at the time of recruitment. This allowed us to gather more potential participants. Because groups were assigned randomly after recruitment and DIET Tracker accounts were created by our team and not the participant, the participant was required to do less work in order to be a part of our study.

During our recruitment, we excluded students on special or therapeutic diets, students with major food allergies, and students who did not have a school meal plan. Our target sample size was a minimum of 100 students from the freshman and sophomore classes. We wanted to reach this number of total participants per study because then we

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could allocate 30 students per group, making each group large enough to test for statistically significant differences. As part of our recruitment, we offered custom-made water bottles with our team logo, while supplies lasted. As an additional incentive to sign up for the study, all participants were entered into a raffle to win an iPod Touch in the Fall 2011 study and an iPod Nano in the Spring 2012 study. We did not offer participants any incentives to log onto the DIET Tracker because doing so would influence desire to use the DIET Tracker, confounding our results. Instead, the raffle winner for each study was selected using a weighted system that gave more active users a better chance of winning. For both studies, participants were given one chance (one random number) to win the raffle for just participating in the study. Additional chances (random numbers) were given to participants for every five meals they created and tracked on the DIET Tracker. Users with access to the DIET Tracker were informed of the weighted system at the start of the study. At the end of each study, a raffle winner was drawn using a random number generator.

**Data collection.** All participants in both the Fall 2011 and Spring 2012 studies were required to complete a pre-test survey. This survey collected basic informed consent (Appendix B), demographic information, responses to the EAT-26 (Appendix C), and responses to a self-efficacy test (Appendix F) for each participant. All components of the pre-test survey were compiled in a Google Form that was sent to all participants via email. Upon completion of the survey, individuals were randomly assigned to a group.

For both Fall 2011 and Spring 2012 studies, the self-efficacy scores of our participants before and after the website intervention served as our primary data. At the beginning of each study, participants took Henry et al.'s (2006) self-efficacy test, used

with permission, as part of the pre-test survey. The self-efficacy test is a comprehensive, nine-item scale that measures one's confidence to eat fruits and vegetables in different situations. Each question is scored on a five-point Likert scale, and one's overall self-efficacy score ranges from 9 (not at all confident) to 45 (very confident) (Henry et al., 2006). At the end of each study, participants took the same self-efficacy test as part of the post-test survey. We used both scores to quantify how each participant's self-efficacy changed during the study.

Website usage data was another form of data that we collected and analyzed during both studies. These data included how many meals each participant created during the study, and in the case of the Spring 2012 study, whether or not the participant activated his or her DIET Tracker account.

We also obtained qualitative information from our participants who used the DIET Tracker to evaluate the online tool for its usability, effectiveness, and accuracy. Our team used these qualitative data to improve the DIET Tracker and gauge future directions for educational website development. We therefore included a DIET Tracker usability test in the post-test survey that all participants who used the DIET Tracker were required to complete. This survey asked which features of the DIET Tracker our participants used the most, what features they liked, and what features they did not like. It also included several open-ended questions where participants could give more detailed responses about their experience with the DIET Tracker. The full usability test can be found in Appendix G.

**Statistical Analysis.** The majority of our statistical analysis was completed using Minitab 16. In addition to using the descriptive statistic and graphical features of the

software, we compared mean values of similar populations of participants with t-tests, and used ANOVA tests to determine correlations between variables and results. All analysis was completed using a 95% confidence interval to determine statistical significance. Using these methods, we compared different groups of participants based on the following characteristics: gender, class year, age, height, weight, BMI, residence hall location, residence hall type, and pre-test self-efficacy scores. We then tested outcomes of our intervention comparing change in self-efficacy between control and experimental groups, as well as by characteristics. More information on our analysis can be found in the Results section.

**Phone Interview Data Collection.** As a final method to receive qualitative feedback from participants about the website, eleven participants were chosen to receive brief, two-to-five minute phone interviews. Four participants answered via email, as they were unable to speak on the phone at the time we called them. The selected participants were chosen based on their meal entry data, as users who entered more meals would have a better recollection of the experience and thus would have a higher probability of providing meaningful data. The participants were selected from both the Fall 2011 and Spring 2012 studies.

The participants were asked a range of questions, as shown in Appendix H. The questions were designed to investigate both the positive and negative aspects of the website. These data provided useful information that can be implemented for future websites' development. The questions were also used to gain insight into participants' motivation for active participation in the study and frequent use of the website. The participants' responses were recorded anonymously and separated into three categories:

positive aspects of the website, negative aspects of the website, and recommendations. The categorized responses were analyzed in order to help explain and further our discussion of the acquired quantitative data.

### **DIET Tracker Design**

**Database and web technologies.** Our team created a nutrition tracking web application and food database for our participants to access over the course of our study. Together, both of these technologies were known as the DIET Tracker. We developed and hosted the DIET Tracker on a Mac Mini server to be found at [diettracker.umd.edu](http://diettracker.umd.edu).

The food database contains the nutrition information of the foods served at the University of Maryland's North and South Campus Dining Halls and some foods commonly found at grocery stores and popular restaurants near campus. The nutritional information for foods found in the dining halls was retrieved from the University of Maryland's Dining Services website.

We used the relational database management system, MySQL, for our database design. We chose Ruby on Rails, a free system that interacts with our database, for our web development environment. Fast, customizable search functionality is provided by Sphinx, a free and open source search engine, in conjunction with Asynchronous JavaScript (AJAX) and JavaScript Object Notation (JSON). AJAX was used to fetch the data in the background, without interfering with the user, to fetch search results sent using the JSON data interchange format to populate the search results for the user. Interactive, dynamic front-end features were implemented using jQuery, a free and open source JavaScript library specializing in client-side scripting. Finally, Airbrake, an error

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collecting and reporting app, was used for better error handling and quick notification of any issues that might have come up during the study.

The web application we designed provided users with dietary analysis similar to the USDA MyPyramid Tracker (currently known as the SuperTracker). Nutritional information for each food such as calories, fat, sodium, and sugar, was stored in our database.

**Web application features.** The web application portion of the DIET Tracker contained many tools and features that our participants could use to gain a better understanding of what they were eating while in our study. During our research, the web application underwent two main updates (once before the Fall 2011 study and once before the Spring 2012 study) where new features were added and user interface was improved. Because of this, the web application portion of the DIET Tracker differs slightly from the Fall 2011 and Spring 2012 studies. Since a different recruitment method was used and there were changes made to the website intervention, we elected to have two independent studies. A flowchart depicting how a user might navigate the website is included in Appendix I. Sample screenshots of the web application portion of the DIET Tracker for both fall and spring can be found in Appendix J and K respectively.

For both the Fall 2011 and Spring 2012 studies, the web application included the following features: meal-tracking (Figures J1 and K1 in Appendices J and K, respectively), a profile page (Figure K5 in Appendix K), a help page, and feedback. Using the feedback from the fall participants, a search function, a nutrition message page and video tutorials were added for the spring study. For both studies, the home page of the web application displayed a calendar interface. Users could select a day and then add



the foods that they consumed. After this information was submitted, the user was shown the nutrition facts for each food in the meal, displayed as a nutrition label, and a chart showing a breakdown of the foods and certain nutrients eaten in the meal as a whole. This breakdown included sugars, sodium, calories and fats and total intake of fruit and vegetables. We chose to focus on these nutrients because they are commonly found on Nutrition Facts labels. The calendar interface of the home page showed users at-a-glance information of the specific nutrients and foods eaten that day.

Users were able to customize different settings via the profile feature. For both the Fall 2011 and Spring 2012 studies, users were able to add and create custom foods. A custom food is a food whose nutritional information is entered in manually and is not included in our food database. In the Spring study, additional functionality enabled users to set email reminders and choose their level of physical activity. Users could choose the days of the week they wanted to receive an email reminding them to use the website. Additionally, users could search the database for information and composition of a food without having to explicitly add a meal.

The analysis feature on the web application allowed users to track their nutrition history over time. With this feature, individuals were able to monitor calorie, fat, sodium, and sugar consumption over each month in the form of a line graph. Participants could see what days they over-consumed and under-consumed certain nutrients according to the Dietary Guidelines.

The web application also showed users the recommended daily value of nutrients, based on the Institute of Medicine's (IOM) data for a 2000-calorie diet by default. After the update for the spring study, the web application could also adjust these values to

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reflect the user's activity level if he or she provided that information. Additionally, in both the Fall and the Spring, we released a new nutrition tip each week during the study. These tips were sent via email to experimental group two only. However, we provided a list of all previous tips on the website that all experimental participants were about to access. These nutrition tips can be seen in Figures K13, K14, K15, K16, K17, K18, and K19 of Appendix K.

The web application also included a help section, with tutorial videos and a frequently asked questions page. The tutorials described how to use basic features of the website, such as adding meals, adding custom foods, and using the search and calendar features. Finally, each page had a feedback and support tab at the bottom right corner of the window, which enabled users to report problems, ask for assistance, or give suggestions and other feedback.

Participants logged onto the web application using the University of Maryland Central Authentication System (CAS). CAS requires a University of Maryland directory ID and password, ensuring a level of security to our participants' data and personal information that they provided. In addition, it restricts our web application to University of Maryland students who have enrolled in our program. Screenshots of the site in the fall and spring are included as Appendices J and K, respectively.

**Website Analysis.** Our diet-tracking tool provided personalized feedback based on the meals that the user reported. This feedback consisted of daily summaries, monthly summaries in a calendar view, and trend tracking in targeted nutrient groups. The web application used detailed nutritional information published by Dining Services through the Aurora Information Systems' Food Pro web tool.

Users could view daily summaries after submitting a meal or by clicking on a date in the calendar homepage. The summary showed a bar graph of the user's total intake of five nutrient and food groups: calories, sodium, fats, sugars, and fruits and vegetables for the day. The nutrients were shown as a percentage of daily recommendations from the IOM. The site personalized these recommended values by use of self-reported gender, age, and activity level information. For example, the calorie recommendation for a 20 year old male who is moderately active is based on a 2,800 calorie diet while the recommendation for 20 year old female who is active is based on a 2,400 calorie diet. The daily view also allowed users to see the specific nutrition label for each food entered on that day. The nutrition label listed the percent daily values for protein, carbohydrates, cholesterol, and calcium in addition to the categories listed in the daily summary (calories, sodium, fats, sugars, and fruits and vegetables). Nutrition data was taken from the Aurora Information Systems' Food Pro web tool and other online nutrition databases. Therefore, as a part of the daily summaries, users were able to see both the specific foods they ate and their total consumption for the day.

The monthly summary view showed a smaller version of each of these daily summary graphs in a calendar. For each day that the user tracked a meal, he or she could see the bar graph based on their specific recommendations from the IOM. Users could not see specific meal information from this page, but could click on the date to view the daily summary. This view allowed users to see general trends in their nutrition across the month.

The trend tracking analysis tool took information from all of the tracked meals in a month and displayed it as a line graph. Users had the ability to isolate particular

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nutrients to view as well as view all five at once. This feature allowed users to see changes in their general eating habits over time. Participants with fairly stable dietary habits likely saw a relatively horizontal trend line, while participants who changed their habits likely saw more upward and downward trends. In this way, users with specific goals for intake could track their progress.

## **Results**

### **Participant Characteristics**

For this study of participant self-efficacy change regarding fruit and vegetable consumption, demographic information was examined to assess the comparability of the experimental and control groups. This information was also used to identify any potential external factors that may have contributed to self-efficacy change. For each sample studied, both Fall 2011 and Spring 2012, three groups were compared: one control group and two experimental groups.

The purpose of the pre-test surveys was to collect information about each participant's eating attitudes, gender, graduation year, residence hall location and style, age, self-reported height and weight (from which BMI was calculated), and self-efficacy to eat fruits and vegetables. Results were analyzed for every participant who completed both the pre-test survey and the post-test survey. In the Fall 2011 study, recruitment took place primarily on North Campus, which is comprised mostly of housing for freshmen and sophomores. Survey responders who did not live on campus were excluded from participation in the study, as well as those who did not have dining plans. In the Spring 2012 study, recruitment took place on both North and South Campus, and off-campus participants were permitted.

The data collected from the Fall 2011 study can be seen in Table 1. The total number of responses was 78 including 36 in the control group, 22 in the first experimental group, and 20 in the second experimental group. As shown, all of the groups contained more women than men (58% for control, 68% for experimental one,

and 70% for experimental two). Most of the participants overall were freshmen and sophomores (75% overall, 75% for control, 82% for experimental one, 90% for experimental two). The majority of participants lived on campus. Specifically, most participants lived on North Campus in traditional dormitory-style residence halls. Most participants were between 18 and 21 years old, and all of the groups had height, weight and BMI information within normal ranges. All the groups had similar initial self-efficacy scores. All groups began with moderately high levels of self-efficacy, ranging from 32-34 points.

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Table 1

*Participant Characteristics for Fall 2011 (Numbers of People)*

Characteristics	Control	Experimental Group 1	Experimental Group 2
<b>Gender</b>			
Men	15	7	6
Women	21	15	14
<b>Class Year</b>			
Freshman	12	9	8
Sophomore	15	9	10
Junior	6	4	2
Senior	3	0	0
All Except Freshman	24	13	12
<b>Residence</b>			
North Campus	23	20	20
South Campus	12	2	0
<b>Residence Style</b>			
Hall Style	28	18	15
Suite/Apartment	1	2	0
Pod-style	8	2	5
<b>Age</b>			
18	9	10	8
19	17	7	8
20	8	2	4
21	1	3	0
Average Height (in)	67	67	66
Average Weight (lbs)	146	147	141
Average BMI	22.8	22.7	22.9
Average Pre-test Self-Efficacy	32.1	34.2	32.5
Minimum Pre-Test Self-Efficacy	13	24	16
Maximum Pre-Test Self-Efficacy	44	45	40

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Similarly, the data collected from the Spring 2012 study can be seen in Table 2. The total number of responses was 136: including 33 in experimental group one, 43 in experimental group two, and 60 in the control group. Unlike the Fall 2011 study, not all of the groups contained more women than men (33% for experimental group one, 60% for experimental group two, 57% for control group). No statistically significant difference was found between BMI of these groups, thus they are comparable in terms of anthropomorphic measures. Similar to the Fall 2011 study, most of the participants in the Spring 2012 study were freshmen and sophomore participants (67% overall, 60% for control, 73% for experimental group one, 72% for experimental group two), living on campus in traditional dorm-style residence halls. The Spring 2012 study included more participants, but the vast majority were still between 18 and 21 years old. All three groups had comparable pre-test self-efficacy scores, although with more variability than was observed in the Fall 2011 study. The control group had the highest average score, followed by experimental group two, followed by experimental group one. As with the Fall 2011 study, the majority of participants started with a moderately high self-efficacy, ranging from 32 – 35 points.

Table 2

*Participant Characteristics for Spring 2012 (Numbers of people)*

Characteristics	Control	Experimental Group 1	Experimental Group 2
Gender			
Men	26	22	17
Women	34	11	26
Class Year			

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Freshman	21	14	16
Sophomore	15	10	15
Junior	10	6	7
Senior	14	3	3
All Except Freshman	39	19	25
Residence			
North Campus	40	25	29
South Campus	8	10	14
Off-Campus	12	0	0
Residence Style			
Hall Style	36	25	31
Suite/Apartment	5	2	8
Pod-style	7	8	4
Age			
18	17	14	15
19	17	8	13
20	13	8	9
21	8	4	6
22	2	2	0
23	1	0	0
24	1	0	0
25	0	0	0
26	1	0	0
Average Height (in)	67	69	66
Average Weight (lbs)	144	155	144
Average BMI	22.5	22.9	23.3
Average Pre-Test Self-			
Efficacy (SE)	35.4	31.9	33.9
Minimum Pre-test SE	16	16	20
Maximum Pre-test SE	45	44	44

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From the characteristics included in these tables, it is clear that the participant groups are sufficiently similar to be compared to one another. They had similar age, residence hall style, class year, and body proportion distributions. The main difference between the participant groups is the gender distribution.

**Comparison of Fall and Spring Studies.** The Fall 2011 and Spring 2012 studies were not wholly equivalent regarding self-efficacy. The pre-test scores among Spring participants were on average 1.24 points higher than fall participants' pre-test scores. Spring participants' self-efficacy scores remained fairly consistent while fall participants' scores decreased by about half a point on average. Also, the difference between participants' post-test self-efficacy scores was statistically significant ( $p=0.048$ ), though there was no statistically significant difference found between their pre-test self-efficacy scores. In the Spring 2012 study, comparison of pre-test and post-test self-efficacy scores showed an increase of 0.152 points on the average, while in the Fall 2011 study, self-efficacy scores decreased by an average of 0.512 points. The difference was statistically significantly ( $p=0.003$ ) more prominent among men, with an average self-efficacy score increase of 1.515 points in the Spring 2012 study compared with an average decrease of 2.107 points in the Fall 2011 study. Conversely, in the Spring 2012 study women's self-efficacy scores decreased by 1.097, while in the Fall 2011 study women's self-efficacy scores increased by an average of 0.380, showing milder trends.

### **Presentation of Results by Group**

In order to evaluate the impact of our diet-tracking website on the dietary self-efficacy of the participants, we analyzed the pre-test and post-test self-efficacy scores of

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each of the three groups. The self-efficacy data by group for both the Fall 2011 and Spring 2012 studies are shown in Table 3.

Table 3

*Self-Efficacy Data by Experimental Group*

	Control Scores			Experimental Group 1 Scores			Experimental Group 2 Scores		
Fall 2011	(n = 36)			(n = 22)			(n = 20)		
	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
Pretest	13	44	32.11	24	45	34.18	16	40	32.50
Posttest	9	41	31.56	22	44	33.82	21	45	31.90
Change	-12	13	-0.56	-9	11	-0.36	-11	9	-0.60
Spring 2012	(n = 60)			(n = 35)			(n = 43)		
Pretest	16	45	35.13	16	44	32.25	20	44	33.99
Posttest	17	45	34.62	13	43	32.05	17	45	34.29
Change	-14	10	-0.51	-11	12	-0.19	-8	14	0.29

**Control group change in self-efficacy results.** In the Fall 2011 study, individual control group pre-test scores ranged from 13 to 44 points, and the average self-efficacy was 32.11 points. Individual post-test self-efficacy scores ranged from 9 and 41 points. The average post-test score was 31.56 out of 45 points. The overall change in self-efficacy for the control group in the Fall 2011 study, from pre-test to post-test, ranged

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from -12 to +13 points. The average self-efficacy change from pre-test to post-test for the control group for the Fall 2011 study was -0.56 points.

In the Spring 2012 study, individual pre-test scores of the control group ranged from 16 to 45 points, and the average was 35.13 out of 45 points. Individual post-test self-efficacy scores of the control group ranged from 17 to 45 points, and the average was 34.62 out of 45 points. The overall change in self-efficacy for the control group in the Spring 2012 study ranged from -14 to +10 points, and the average change was -0.51 points.

There was no statistically significant difference between participants' self-efficacy score changes between the two studies. However, there was a significant difference between fall and spring participants' pre-test ( $p = 0.025$ ) and post-test ( $p = 0.008$ ) scores. On average, participants in Fall 2011 scored 3.27 points less on their pre-tests than Spring 2012 participants. This gap increased to 3.73 points when these same participants took their post-test surveys.

**Experimental group one results.** In the Fall 2011, experimental group one had pre-test scores for self-efficacy that ranged from 24 to 45 points with an average score of 34.18 points. The range of post-test scores was 22 to 44 points, and the average score was 33.82 points. The overall change in score for this group ranged from -9 to +11 points, and the average change was -0.36 points.

In the Spring 2012 study, the pre-test scores of experimental group one ranged from 16 to 44 points, and the mean score was 32.25 points. The range of post-test scores was 13 to 43 points with a mean score of 32.05 points. The overall change in self-efficacy

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ranged from -11 to +12 points, and the average change was -0.19 points. This is shown in Table 3.

In the Fall 2011 study, individual participants in experimental group one tracked between a minimum of 0 and maximum of 168 meals, with details shown in Table 4. Twenty of the 22 participants in experimental group one in the Fall 2011 study logged at least one meal on the website.

In the Spring 2012 study, individual participants in experimental group one tracked between a minimum of 0 and maximum of 15 meals, with details shown in Table 4. Eleven of the 18 participants who activated their accounts in experimental group one in the Spring 2012 study logged at least one meal on the website, while 17 participants did not activate their accounts on the website.

No significant differences were found between experimental group one and control group self-efficacy scores in the Fall 2011 study. However, in the Spring 2012 study, statistically significant differences were found between experimental group one and the control group with respect to pre-test scores ( $p = 0.012$ ) and post-test scores ( $p = 0.019$ ). Experimental group one on average had a lower score than the control group by 2.88 points on the pre-test and 2.57 points on the post-test. When examined by gender, it appears that women accounted for most of the differences between experimental group one and the control. The difference between women in the Spring 2012 experimental group one and in the control group were statistically significant in pre-test score ( $p = 0.024$ ) and post-test score ( $p = 0.044$ ), while the difference between men in experimental group one and in the control group were not statistically significant. However, note that sample sizes were small, and statistical significance may not be accurate.

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**Experimental group two results (e-mail reminders).** In the Fall 2011 study, experimental group two had individual self-efficacy pre-test scores ranging from 16 to 40 points, with an average score of 32.50 points. The range of post-test scores was 21 to 45 points, and the average score was 31.90 points. The overall change in score for the group ranged from -11 to +9 points, and the average change was -0.60 points.

In the Spring 2012 study, the pre-test scores of experimental group two ranged from 20 to 44, and the mean score was 33.99 points. The range of post-test scores was 17 to 45 points with a mean score of 34.29 points. The overall change in self-efficacy ranged from -8 to +14 points, and the average change was 0.29 points. There were no statistically significant differences found in self-efficacy between members of this group and the control group, in both the Fall 2011 and Spring 2012 studies. This is shown in Table 3.

In the Fall 2011 study, there were no statistically significant differences found in self-efficacy between members of experimental group two and the control group. The number of meals reported by participants in experimental group two ranged from a minimum of 0 to a maximum of 81 meals, as shown in Table 4. Seventeen of the 20 participants in experimental group two in Fall 2011 logged at least one meal.

In the Spring 2012 study, individual participants in experimental group two tracked between 0 and 46 meals, as shown in Table 4. Twenty-one of the 43 participants in experimental group two activated their accounts on the DIET Tracker after completing the pre-test. Of those 21, only three of them chose to receive email reminders. Two participants chose to receive reminders one day each week, and reported two meals and four meals, respectively over the course of the study. One participant chose to receive one email reminder. This participant logged 46 meals over the course of the study, which was

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the highest number of meals tracked by any individual in the Spring 2012 trial. Note that participants in the Fall 2011 study were not given a choice of whether or not to activate their accounts, because the accounts were activated upon recruitment.

Table 4

*Meals Tracked*

Number of meals	Experimental Group 1 Participants	Experimental Group 2 Participants
Fall 2011		
0	2	3
1	3	2
2	3	3
3	0	1
4	1	1
Over 5	13	10
Unactivated	N/A	N/A
Spring 2012		
0	7	3
1	5	9
2	1	2
3	0	2
4	0	2
Over 5	5	3
Unactivated	17	22

### **Self-Efficacy by Demographic Information**

We analyzed pre- and post-test self-efficacy scores by gender, graduation year, housing type, height, weight, body mass index, and meals created on the DIET Tracker. For the following testing methods, all relevant figures can be found in Appendix L.

**Gender.** Differences were found in self-efficacy scores between men and women participants in both trials. In the Fall 2011 study, the difference in self-efficacy score change among men and women was statistically significant ( $p = 0.04$ ), with women's scores increasing by a mean of 0.38 points and men's scores decreasing by a mean of 2.11 points from pre- to post-test score, as shown in Table 5. In the Spring 2012 study, the differences between men and women were statistically significant ( $p = 0.002$ ), with women's scores decreasing by a mean of 1.10 points, while men's scores increased by a mean of 1.52 points, opposite to the results seen in the Fall 2011 study from pre- to post-test score, as shown in Table 5. Pre-test, post-test, and change information is summarized in Tables 3 and 5.



Table 5

*Average Self-Efficacy Scores by Gender for Fall and Spring for All Groups*

	Men	Women
Fall 2011		
	(n =28 )	(n = 50)
Pre Test	33.46	32.42
Post Test	31.36	32.8
Change	-2.11	.38
Spring 2012		
	(n = 65)	(n = 71)
Pre Test	32.73	35.24
Post Test	34.24	34.14
Change	+1.515	-1.907

Gender difference data are summarized in Tables 5 and 6 and in Figures L1, L3 and L4 of Appendix L. In the Fall 2011 semester, women had a smaller range of score changes than men, with a minimum of -9 and a maximum of +11 points, while men ranged from -12 to +13 points (Figure L3). In the Spring 2012 study, women also had a slightly smaller range of score changes than men, with a minimum of -14 and a maximum of +11 points, while men ranged from -13 to +14 points (Figure L4).

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Table 6

*Change in Self-Efficacy Score by Gender for Fall and Spring*

	Men	Women
Fall 2011		
	(n =28 )	(n = 50)
Mean	-2.11	.38
Median	-2	1
Spring 2012		
	(n = 65)	(n = 71)
Mean	+1.515	-1.907
Median	1	-1

No statistically significant difference in pre-test scores was found between men and women in the Fall 2011 study. However, a statistically significant difference ( $p = 0.024$ ) was found in the Spring 2012 study, with a mean pre-test score among men of 32.73 points and a mean pre-test score among women of 35.24 points, with a difference of 2.51 points. This data is summarized in Table 7, and in Figures L3 and L4 of Appendix L.

Table 7

*Pre-Test Self-Efficacy Score by Gender for Fall and Spring*

	Men	Women
Fall 2011		
	(n =28 )	(n = 50)
Mean	33.46	32.42
Median	34.50	33.50
Spring 2012		
	(n = 65)	(n = 71)

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Mean	32.73	35.24
Median	32	36

No statistically significant differences between men's and women's post-test scores were found in either the Fall 2011 or Spring 2012 studies. Information on this analysis is summarized in Table 8, as well as in Figures L5 and L6 of Appendix L. In the Fall 2011 study, both men and women had similar score ranges, as seen in Figure L7.

Table 8

*Post-test Self-Efficacy Scores by Gender for Fall and Spring*

	Men	Women
Fall 2011		
	(n = 28)	(n = 50)
Mean	31.36	32.80
Median	31.50	34
Spring 2012		
	(n = 65)	(n = 71)
Mean	34.24	34.14
Median	35	35

**Pre-test vs. post-test results by gender.** We found that pre-test scores were good predictors of post-test scores for both men and women in the Fall 2011 study and the Spring 2012 study. This means that, generally, participants who had low pre-test self-efficacy scores ended up with the same scores after taking the post-test. The data is summarized in Table 9, as well as in Figures L7 and L8 of Appendix L. As discussed previously, men's scores in the Fall 2011 study decreased from an average 33.46 to 31.36, while women's scores increased from 32.42 to 32.80. In contrast, in the Spring

2012 study, men's scores increased from 32.73 points to 34.24 points, and women's scores decreased from 35.24 points to 34.14 points. Despite these differences, men's and women's scores were distributed similarly as seen in Figures L7 and L8 of Appendix L.

Table 9

*Average Pre-test and Post-test Self-Efficacy Scores by Gender for Fall and Spring*

	Men	Women
Fall 2011		
	(n = 28)	(n = 50)
Average	33.46	32.42
Pre-Test Score		
Average	31.36	32.80
Post- Test Score		
Spring 2012		
	(n = 65)	(n = 71)
Pre avg.	32.73	35.24
Post avg.	34.24	34.14

**Graduation year.** There were no statistically significant differences among participants of either gender by year of graduation in the Fall 2011 and Spring 2012 studies. This data is summarized in Table 10, as well as in Figures L9 and L10 of Appendix L. In the Fall 2011 study, men of all graduation years saw a decrease in self-efficacy score, with self-efficacy score change ranging from -3 to -.5 points. Women had mixed results: both 2012 and 2013 graduates saw decreases in scores, while 2014 and

2015 graduates increased their self-efficacy. When combined, fall participants as a whole decreased their scores on average. In the Spring 2012 study, results were the opposite. With the exception of 2012 graduates who decreased 1 point on average, all other men of any graduation year increased their score, with self-efficacy score change ranging from 1 to 3 points. Women as a whole decreased in average score, ranging from a decrease of 3.73 for 2013 graduates to a decrease of .22 for 2012 graduates. With both genders combined, 2012 and 2013 graduates saw a decrease in average score, while 2014 and 2015 saw an increase. However, none of these differences are statistically significant.

Table 10

*Change in Self-Efficacy Score by Graduation Year by Gender for Fall and Spring*

	Both Genders		Men		Women	
	Mean	Median	Mean	Median	Mean	Median
Fall 2011						
2012	-2	-2	-1	-1	-4	-4
2013	-.83	-.5	-.67	-.5	-1	-1
2014	-.15	0	-2.8	-1.5	+.96	+1.5
2015	-.66	-1	-2.5	-3	+.32	+1
Total No.	78		28		50	
Spring 2012						
2012	-.8	-1	-1.27	-1	-.22	0
2013	-1.57	-2	+2.5	+3	-3.73	-3
2014	+.85	+1	+2.05	+2	-.4	-.5
2015	+.71	-.5	+1.96	+1	-.46	-1
Total No.	136		65		71	

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**Housing type.** There were no statistically significant differences among participants of either gender by residence hall housing types in the Fall 2011 and Spring 2012 studies. This data can be found in Table 11, as well as in Figures L11 and L12 of Appendix L. In the Fall 2011 study, men's average scores decreased for all styles of housing, while only women living in suites and apartments saw a decrease in average score. As a group however, Fall 2011 participants decreased in score in all but semi-suite style housing, though differences between groups were small. In the Spring 2012 study, men's scores increased for participants living in all styles of housing, with minimal differences in score between housing styles. Women's scores decreased with the exception of suites and apartments. As a group, spring participants saw minimal increases in score on average for all but off-campus participants, who saw a decrease in average score. However, none of these differences are statistically significant.

Table 11

*Changes in Self-Efficacy Score by Housing Style for Men and Women*

	Both		Men		Women	
	Mean	Median	Mean	Median	Mean	Median
Fall 2011						
Hall-Style	-.542	-1	-1.9	-2	+.211	+.5
Semi-Suite	+.07	+1	-3.6	-4	+1.9	+2
Suite/Apartment	-2.25	-3	-.5	-.5	-4	-4
Total No.	78		28		50	
Spring 2012						
Hall-Style	+.315	-1	+1.605	1	-.816	-1
Semi-Suite	+.083	-.5	+.29	2	-.2	-1
Suite/Apartment	+1.62	+1	+1.86	1	+1.33	1
Off-Campus	-1.43	-2	+1.78	2	-3.83	-4

## RESULTS

Total No.	136	65	71
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**Anthropometric measures.** There were no significant correlations between height, weight, or body mass index and self-efficacy scores for men or women in Fall 2011 and Spring 2012 studies. Table 12 summarizes the anthropometric measures of the participants of our two studies. Our participants had similar body measures in Fall 2011 and Spring 2012 studies. Men had an average height of 69 inches in the Fall 2011 study, and 70 in the Spring 2012 study, with average weights of 153 lbs. and 157 lbs. for those periods. Women had an average height of 65 inches in the Fall 2011 study and 64 in the Spring 2012 study, and on average weighed 139 and 137 lbs. respectively. In the Fall 2011 study, men had an average BMI of 22.4, and 22.3 in the Spring 2012 study. Women had an average BMI of 23.0 in the Fall 2011 study and 23.2 in the Spring 2012 study. Figures L13 and L14 in Appendix L show both the Fall 2011 and Spring 2012 study participants' change in self-efficacy score by BMI. Data shows no significant differences between by body measures and change in self-efficacy.

Table 12

*Average Height, Weight, and Body Mass Index by Gender for Fall and Spring*

	Men		Women	
	Mean	Median	Mean	Median
	Fall 2011			
Height	69.23	69.5	65.28	65
Weight	153.61	152.5	139.54	137.5

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BMI	22.46	22.35	23.01	22.36
Total No.	28		50	
<hr/>				
Spring 2012				
Height	70.212	70	64.507	64.5
Weight	157	155	137.69	130
BMI	22.342	21.771	23.275	22.463
Total No.	65		71	
<hr/>				

**Meals created with DIET Tracker.** Among participants with access to the website in the Fall 2011 study, there was no statistically significant difference between the number of meals added by men and the number of meals added by women. However, in the Spring 2012 study there was a statistically significant difference between men and women in number of meals added ( $p = 0.049$ ), with women adding a higher number of meals than men on average, as shown in Table 13. This trend was more strongly seen in experimental group one.

There was no correlation between graduation year, or apartment style and the number of meals added. Additionally, fall participants added a statistically significantly higher number of meals than spring participants ( $p = 0.000$ ), as shown in Table 13.

Meal creation data are summarized in Table 13. In the Fall 2011 study, men created a total of 221 meals, while women created 453, though a large proportion of those meals were created by a small number of participants. On average, men created 17 meals, and women created an average of 15.62 meals. In the Spring 2012 study, men created a total of 25 meals, while 123 meals were created by women. Individual men created on



average .63 meals, while individual women created on average 3.2 meals. This data is also illustrated in Figures L15 and L16 of Appendix L. There were no statistically significant correlations between the number of meals created and change in self-efficacy score.

Table 13

*Meals Created with DIET Tracker by Gender for Fall and Spring*

	Men	Women
Fall 2011		
Mean	17	15.62
Total Meals Created	221	453
Number of Participants with Access*	13	29
Spring 2012		
Mean	.63	3.2
Total Meals Created	25	123
Number of Participants with Access*	40	37

\*Denotes only those participants with access to the DIET Tracker.

### **Self-Reported Web Site Usage**

Our findings from the DIET Tracker usability test provided us insight into how effective our participants believed the DIET Tracker was. The amount of self-reported

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website use was different between the fall and spring studies. Participants of the Fall 2011 study reported a statistically significantly higher level of website use ( $p=0.008$ ) than participants of the Spring 2012 study. Website use was determined by looking at participants' survey responses and collecting data from their reported frequency of use, as well as their reported feature use. Unfortunately, this self-reported website use was not consistent with actual use data collected by the website. For example, many participants who never activated their accounts still self-reported frequent website use, and many participants who reported adding a meal never actually did.

**Fall 2011 study.** During the Fall 2011 study, 67% of our participants reported using the DIET Tracker only one to two times per month, while only 10% reported using the DIET Tracker daily or three to four times per week. There was no statistically significant difference between the self-reported website use of men and women. When asked about which functions of the DIET Tracker our participants used, 74% of participants said the searching food feature. Eighty-three percent (83%) reported using the “add a new meal” feature, and 55% said they used the calendar feature. Less popular features of the DIET Tracker seemed to be the analysis page, the feedback and support tab, and the tutorial videos as only 16%, 9%, and 7% of participants reported using these items, respectively. On a Likert scale from 1 (poor on this dimension) to 7 (excellent on this dimension), 81% of our participants rated the DIET Tracker a 4, 5, or 6 in ease of use, meaning a large majority of users had positive thoughts regarding the tool's usability.

Accessing the DIET Tracker from a mobile device did not appear to be a popular method for our participants in the Fall 2011 study as only 16% reported doing so.

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However, when asked about how valuable a mobile app version of the DIET Tracker would be, 79% of participants said they were willing to pay at least \$0.99 to obtain it. Sixty-nine (69%) percent of participants reported that they would recommend the DIET Tracker to a friend to use. Seventy-six percent (76%) of our participants reported that they would be more likely to use the DIET Tracker if the website could automatically track the foods they ate at the University of Maryland Dining Halls.

**Spring 2012 study.** During the Spring 2012 study, 53% of our participants reported using the DIET Tracker only one to two times per month, while only 5% reported using the DIET Tracker daily or three to four times per week. The remaining participants did not report accessing the website. There was no difference in self-reported website use between men and women. When asked about which functions of the DIET Tracker our participants used, 59% of participants said the searching food feature. Nineteen percent (19%) reported using the “add a new meal” feature, and 42% said they used the calendar feature. Less popular features of the DIET Tracker seemed to be the analysis page, the feedback and support tab, and the tutorial videos as only 15%, 17%, and 4% of participants reported using these items, respectively. It is interesting that 14% of our participants reported not using any features of the DIET Tracker during the duration of the study. On a Likert scale from 1 (poor on this dimension) to 7 (excellent on this dimension), 68% of our participants rated the DIET Tracker a 4, 5, or 6 in ease of use, meaning most users had positive thoughts regarding the tool’s usability.

Just as in the Fall 2011 study, accessing the DIET Tracker from a mobile device did not appear to be popular. Ninety-four percent (94%) of participants reported not accessing the DIET Tracker from a mobile device, and only 49% said that they would be

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willing to pay at least \$0.99 for a mobile version of the DIET Tracker if it were to be offered.

Fifty-eight percent (58%) of participants reported that they would recommend the DIET Tracker to a friend to use. Forty-five percent (45%) of our participants reported that they would be more likely to use the DIET Tracker if the website could automatically track the foods they ate at the University of Maryland Dining Halls.

Finally, our usability test in the Spring 2012 study included a question to evaluate the effectiveness of the email messages sent to the experimental groups. On a Likert scale from 1 (had no influence) to 7 (strongly influenced), 62% of participants rated the weekly email messages as having only an effect of 1, 2, or 3. This means that the majority of users did not believe the email reminders had any effect on their use of the tool. Reported frequency of reading these email messages ranged from once a week with 36% of participants reporting doing so to never reading them with 24% of participants reporting this, with the remaining participants falling in between. There was no increase reported by participants in number of meals added based on receipt of email messages.

### **Qualitative Data**

*Fall 2011 Survey.* Participants detailed different reasons for using the DIET Tracker. Some exhibited a concern for their personal health, and wanted to gain more information about the foods they were eating. Others used the DIET Tracker because it was convenient; all meals served in the university dining halls were present on the site, and were updated daily, a unique feature offered only by the DIET Tracker. Some chose to participate because of incentives offered, and others participated in order to help with a study conducted by their peers.

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Responses to open-ended questions gave us specific feedback from participants in our study. Our participants liked that the DIET Tracker was easy to use, informative, specific to the University of Maryland dining halls, and allowed tracking of meals. One participant said, “It really lets me know what I am putting into my body and motivates me to eat healthier.” Another noted, “I liked how easy the program was to use. I maneuvered around the site with ease.” Finally, a third participant commented, “It was very simple to see what I was eating and how much of each category I was eating. It made me alter my eating habits after seeing that the categories were all red for one day.”

Participants also had the opportunity to comment specifically on what features of the DIET Tracker they did not like. Responses were diverse and dealt with the DIET Tracker being confusing, boring, not having enough brand name foods and fast foods to select from, and having technical issues. Surprisingly, one participant mentioned that there was too much information on the DIET Tracker. Some participants said they had trouble using the DIET Tracker because it was too time consuming or they just forgot about it. One participant mentioned, “Maybe too much information for someone who doesn't know a lot about nutrition.” Another said, “On items such as a veggie wrap, I would get every vegetable and vegan beef, so it was hard to tell exactly how many calories were in my wrap (as was the problem for several other items).” Finally, someone commented, “A lot of the things that I need [to] eat were not on the pull down list and I would constantly have to have substitutes for what I did eat, but I never really knew what was the closest item.”

Open-ended responses on the usability test gave us information on possible improvements to the DIET Tracker in the future. Participants wanted a website more

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integrated with specific food stations at the University of Maryland diners. For example, participants wanted the ability to add entire diner value meals or foods from local restaurants instead of having to add every item separately.

***Spring 2012 Survey.*** Participants were motivated to use the DIET Tracker for many of the same reasons as participants in the Fall 2011 study. Some were concerned with their health, others wanted to know the nutritional information of the foods they ate, some used the site because it conveniently displayed items served exclusively at the dining halls, others participated because of incentives, and many simply wanted to help in the study.

Just as in the Fall 2011 study, we asked our participants open-ended questions to give us specific feedback on the DIET Tracker. Once again, our participants liked that the DIET Tracker was easy to use, informative, specific to the university's dining halls, and allowed tracking of meals. Participants this time around also noted that tracking was faster. One participant "really liked having all the UMD meals one click away," and said it was a "big advantage over other tracking services." Another participant said, "It allowed me to really look at all the things I was eating. I didn't realize I ate certain things so often."

Some of the features that our participants in the Spring 2012 study did not like about the DIET Tracker included the analysis pages, not having enough custom foods, needing to customize intake, and overall bugs in the software. Additionally, one participant said that the DIET Tracker "made [me] feel guilty about [my] unhealthy choices."

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Participants had many suggestions for possible improvements to the DIET Tracker. Some wanted their meal input to be split into breakfast, lunch, and dinner sections, while others wanted to see micronutrient analysis. Participants called for automatic meal tracking in the dining halls, but one response indicated a potential problem with this method if it were to be implemented. This participant said, “A potential problem I foresee with [having the] DIET Tracker [track meals] automatically is that I sometimes buy food for my friends. This would show up as my food even though I'm not the one eating it.” Other improvements suggested were implementing a physical activity tracker and providing advice to substitute an unhealthy meal for a healthy one.

**Interviews.** Following each semester-long study, a post-test survey collected some qualitative responses from participants. While this information was helpful and insightful, these surveys did not provide us with an opportunity to ask follow up questions or talk face-to-face with the participants. It was, however, the first opportunity for participants to provide more than numbers or one-word responses. Realizing that these types of responses could not only provide feedback but also recommendations for the future, we decided to pursue phone interviews with a select number of participants from both the fall and spring studies. We chose to interview participants that tracked multiple meals, since they would be more familiar with the website intervention than participants that did not activate their accounts or only logged a few meals. All participants that were chosen indicated that they were willing to be contacted for future research in our post-test surveys.

Many of the interviewees who offered positive experiences from the study claimed that the website was easy to use and that the information presented taught them

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to be more conscious as they made nutritional choices. We hypothesized that the website and study would lead to a high correlation with self-efficacy. While the qualitative data did not provide overwhelming evidence to support our hypothesis, these interview responses at least verified that our study made some impact in the choices that the interviewed participants made while selecting their foods.

While there were generally positive reviews of our website, some participants noted a few drawbacks that could possibly explain why there was attrition with regards to use of the website. Several participants claimed that the website's database did not include many of the foods that they would normally eat. When some full meals were not listed, participants would instead have to enter the individual ingredients that comprised their meals. This became tedious and soon some of these participants lost interest. In fact, some participants said that having to enter their own data could be time consuming or intimidating. Therefore, the website became more of a burden than a useful resource. In the future, studies that involve self-reported meals should make an effort to reduce the amount of time and work required by participants. For example, the need to individually input every ingredient in a meal could be replaced by a more thorough database of common meals, or meals that contain many different ingredients that would otherwise be listed individually. Our website attempted to do this, but we were not thorough enough.

During the course of our study, we had initially hoped to allow for meals to be automatically reported on the website when participants purchased meals using their participant identification cards at the dining halls around campus. While this turned out to be more technologically difficult than anticipated, it does seem logical that participants would have been more apt to check their nutritional analyses had their information been

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updated seamlessly and instantly. In future iterations of a website such as ours, an effort should be made to integrate participant identification swiping at the dining halls with the website. This may increase participants' interest in their food intake and increase self-efficacy. Finally, some participants relayed useful information as to how we could have designed the website better. Participants' recommendations included more complex meal choices, a mobile (smartphone) application, and a more user-friendly experience.

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## Discussion

### Overview

We hypothesized that there would be a significant positive correlation between students' use of a web-based diet tracking tool and their self-efficacy for eating fruits and vegetables. However, we found that our website intervention did not have a significant impact on the self-efficacy scores of participants in the experimental groups as compared to the control group. In both studies, self-efficacy scores remained stable for each experimental group. These results are not consistent with prior literature, which found that computer-based nutritional interventions over a four- to five-week period improved the self-efficacy of participants (Anderson et al., 2001; Normand & Osborne, 2010; Poddar et al., 2010). We conjecture that our tracking tool did not affect student self-efficacy because most participants did not use our tracking tool often enough for it to have a significant impact. Many participants never activated their accounts, did not log any meals, or logged only one meal. The Anderson et al (2001) study likely had more participation than ours because it was two weeks shorter, and the participants received monetary compensation if they completed the survey. Since the students in our study were encouraged but not required to use our tracker, we had much less participation.

Although no significant correlation was found between use of our tracking tool and self-efficacy, there were significant gender differences in self-efficacy found over the course of the study.

### Hypothesis

**Differences between experimental groups.** Participants in both experimental groups had access to our website, but only group two participants were sent a weekly

nutrition message. We hypothesized that the additional nutrition information provided to experimental group two would cause these students to use the website more often than group one. Our results show that reception of the nutrition tips was related to increased website usage in the spring, but not in the fall. We found that out of all the students who activated their accounts in the spring, only 60% of group one participants reported a meal, while 85% of group two participants reported a meal. However, the nutrition message had little effect during the fall study. During this trial, 91% of group one participants reported at least one meal, compared to 86% of participants in experimental group two.

The inconsistency between fall and spring suggests that providing additional nutrition facts may not reliably increase self-reporting, and the increase in self-reporting seen in experimental group two in the spring may have had other causes. However, the metric of whether or not users created meals was more meaningful in the spring, because in Fall 2011, we added a meal to user accounts during recruitment in order to demonstrate how to use the website. While some users deleted this extra meal, others did not and had an extra meal on their account that they did not consume or track themselves. On the other hand, during our Spring 2012 recruitment, we did not create any meals for the participants, relying instead on our website tutorial page to show participants how to navigate the website.

**Differences in website use.** We hypothesized that our intervention would increase users' self-efficacy. Results from both studies suggest that this hypothesis cannot be accepted based on our findings, since there is no strong evidence linking website use with an increase in self-efficacy. However, we did find two important demographic

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differences in website use: the difference between the fall and spring results and the difference between men and women in the spring study.

Fall users with website access tended to use the website more than spring users with website access. The average number of meals added by fall users was much higher than the average number of meals added by spring users. It is possible that the tutorial meals created during recruitment contributed to this trend. However, fall users also reported a greater level of engagement with the website, rating their frequency of use higher on average than spring users, so it is unlikely that meals created during the tutorial process accounted for all of the difference. However, greater use of the website did not reflect an increase in self-efficacy. Fall and spring participants experienced the same overall changes in self-efficacy score whether or not they had access to the website. Factors for which we were not able to control may have overshadowed the effect of website use on self-efficacy. For example, freshman participants may have experienced a maturation effect between their first and second semesters of college (Anderson, Shapiro & Lundgren, 2003).

Regarding the second demographic difference, we found that women added a greater number of meals than men in the spring. At the beginning of this trial, women with website access scored an average of 1.69 points higher than men on their self-efficacy pretest. By the end of the study, this gap narrowed to a margin of less than one-tenth of a point. This occurred because women's average self-efficacy decreased by half a point compared to an average increase of 1.2 points among men. However, during the spring semester the self-efficacy of women in the control group decreased by an average of 1.71 points, three times greater than the decrease experienced by women with website

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access. This result was statistically significant and represents a major experimental effect. The self-efficacy scores of men in the control group increased by an average of 2 points, representing only a small difference from the increase in score of men with website access. Thus, even though women's self-efficacy scores tended to decrease during the semester, women with access to the website experienced a less severe decrease than those who did not have access to the website.

### **Literature Comparison**

**Self-efficacy.** Our results indicate that our interventions had no significant impact on the self-efficacy scores of our experimental groups as compared to the control group. In the fall and spring semesters, both experimental groups had minimal change in self-efficacy score from the pre-test to the post-test. Any changes that did occur were also seen in the control groups and were thus likely to have been caused by outside trends and not by our intervention. This contradicts the literature. Among previous studies there is a consensus that computer-based nutritional interventions increase the self-efficacy of the participants (E. S. Anderson et al., 2001; Franko et al., 2008; Long & Stevens, 2004; Poddar et al., 2010).

A glaring difference between our study and others is that the majority of our participants either did not activate their website account, or they logged fewer than ten meals over the length of the intervention. Overall, we saw retention rates of 55% in Fall 2011 and 56% in Spring 2012. Past studies have been much more successful in terms of participation, experiencing retention rates of 80% or higher (Alexander et al., 2010; Franko et al., 2008; Poddar et al., 2010). With such a low usage rate, it is likely that our

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participants did not experience improvements in self-efficacy simply because they did not use the tool enough to be influenced by it.

Another difference in methodology between our study and others is the frequency and administration of the intervention. For our intervention, participants were free to visit the website at any time and as often as they wanted. However, the administration of other studies has been much more uniform and structured (Anderson et al, 2001; Franko et al., 2008; Long & Stevens, 2004; Poddar, Hosig, Anderson, et al., 2010). In a study by Anderson, et al. (2001), participants visited a computer kiosk each time they went grocery shopping. In Franko, et al. (2008), participants were compelled to visit the intervention website in a few regular sessions spaced throughout the semester. Long and Stevens (2004) had middle school students devote regular periods of class time to their online nutritional education tool, while Poddar, Hosig, Anderson, et al. (2010) had university students use their website once a week for five weeks. Perhaps the well-defined time at which the interventions were administered is the reason that participation in these experiments was so high. Also, while our study requested that the participants enter information about every food item that they ate, other interventions required participants to report food intake information more intermittently. Past research has shown that over time, participants in self-report nutrition studies become fatigued and disinterested and start to severely under-report nutritional intake (Ann Yon et al., 2006; Arab et al., 2010). This participant behavior was seen in our study, and it could have been a large contributor towards the low participation rate in our intervention. Our study was not strictly controlled because we wanted to allow students to access the website to

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increase their knowledge and self-efficacy at their own pace. However, future studies may need to reconsider that approach.

Besides the administration of our intervention, the content of our intervention differed from previous studies on self-efficacy. In our study, the extent of nutrition education we provided was to display foods' nutritional facts, including recommended daily values of certain nutrients, and to email five brief nutrition messages to the second experimental group. However, other interventions provided instructions on how to improve the quality of the participants' diets. For example, some studies provided advice on how to make healthier purchases at the grocery store (E. S. Anderson et al., 2001) or provided a custom educational course based on pre-test surveys taken by the participants (Alexander et al., 2010). Learning how to make healthier food choices increases participants' confidence in making these choices, and thus their self-efficacy (Bandura, 1997). Increasing the amount of nutrition education content in our intervention may have resulted in a greater increase in self-efficacy scores in the experimental groups. However, we are aware that there are many competing demands on college students' time and we did not feel that participants would spend their time reading verbose educational materials. A balance must be struck between content and brevity in order to provide the best materials that students are willing to read.

**Website use.** According to a study of fruit and vegetable consumption in 18- to 24-year-olds following a web-based intervention in which newsletters were periodically sent to participants (A. Richards, Kattelman, & Ren, 2006), 52.3 percent of their experimental group used the accompanying website. Our study showed a comparable level of participation in the spring; about 48 percent of participants in experimental group

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one and just over 50 percent of participants in experimental group two activated their accounts on the website, indicating that they logged on to the site at least once.

In the fall, experimental group one had a slightly higher percentage of participants who used the website compared to experimental group two. The opposite held true in the spring: experimental group two had a 30 percent higher rate of website use than experimental group one. These findings were slightly different from the results of previous studies. In an intervention study of fruit and vegetable consumption behavior in adults aged 21 to 65, Couper et al. (2010) evaluated participant engagement across three different experimental arms of their study. The first arm was a generic intervention not tailored to the participant. The second arm was personalized to the participant, and the third was personalized with additional email support. The researchers found that there was no difference in participation overall across the different study conditions (Couper et al., 2010). These findings are consistent with our results in the fall, as we also did not find significant differences in website usage between experimental group one without email reminders and experimental group two with email reminders. However, there were significant differences found between the two experimental groups in the spring study.

**Gender.** For the most part, self-efficacy scores were not affected by demographic characteristics such as BMI, housing style, housing location on campus, or class year. Our studies did, however, find significant differences between the self-efficacy of men and women, regardless of experimental group. In the fall, women's self-efficacy was on average slightly lower than men's, but it was much more stable over the course of the fall study. Men's self-efficacy started higher but ended lower than women's, which was unexpected. In the spring, women started out with a higher self-efficacy than men by a

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fair margin. However, by the end of the spring study, self-efficacy scores converged to almost the same value, because women's scores decreased and men's scores increased.

Generally, gender differences have been observed in college students' nutritional beliefs, knowledge sources, and self-assessments (Davy et al., 2006; DeBate et al., 2001; Driskell, Meckna, & Scales, 2006; Li et al., 2012; Morse & Driskell, 2009). However, past studies have shown that the relationship between gender and eating habits is not significant (Herbert et al., 1997; Jackson et al., 2009; Kiefer, Rathmanner, & Kunze, 2005; Li et al., 2012).

Our study found a gender difference in self-efficacy, which we expected, since self-efficacy is closely tied to the participants' nutrition beliefs. Whereas previous studies have noted gender differences in beliefs but not behavior, we found statistically significant differences in the meal-tracking behaviors of men and women as well as in their beliefs. We found that women created more meals and were more likely to regularly track their diet. Thus, in this case it appears that the differences in beliefs may have an impact on the observed behaviors of our participants. However, we are not able to draw conclusions about the eating habits of men and women. It is possible that tracking behaviors are more closely related to self-efficacy and awareness than to actual dietary practices, thus accounting for the difference in behavior while not contradicting published results.

**Qualitative feedback.** From our surveys and phone interviews, we found that participants' motivations for joining the study were very diverse. These included the desire to help a research study, learn about nutrition, or obtain the incentive offered for participation. These findings are consistent with Hayman et al., who found that the desire

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to aid in research and to learn are important factors in people's decision to participate in a research study (2001). Partnership, the feeling of identification with a group or community, also proved to be an important motivation for many participants, who said they wanted to help out their fellow students by participating in a research study. This was found to be beneficial in increasing study engagement (Davidson et al., 2010). Additionally, emphasizing the informative aspect of the tool attracted people interested in nutrition. Multiple well-advertised incentives could have drawn more participants to our study. This information is useful to future recruitment strategies that explicitly address these different motivations.

Additionally, we found that our web-based study appealed to many of our users. This finding is consistent with published results, such as those by Poddar et al. (2010) and Normand and Osborne (2010), who found that online nutrition interventions positively increased students' self-efficacy. These studies used emails and posted information as part of their interventions. We added an interactive website to this intervention methodology, and found that our participants liked the convenience, simplicity and instantaneous results provided by our tool. Future studies targeting college students should consider use of an online intervention for increased user engagement (Woodall et al., 2007).

The survey and interview results revealed some room for improvement to our tool. Specifically, some participants felt that the tool was too confusing or not engaging, or that tracking took too much effort or was easy to forget. Many users indicated that they had trouble with the content and navigation of the website, two of the website usability themes outlined by Meyers (2012). Improving these aspects of the website would lead to

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greater participant involvement and engagement (Palmer, 2002). Additionally, the tedium of adding meals discouraged participants from using the tool, which led to low user engagement during the study. For example, many users were unable to find some of the foods they ate, and others had to add each individual ingredient of a complicated meal. The process of tracking nutrition should be simplified in future studies in order to increase website usage (Palmer, 2002). A major improvement to our tool would be the addition of automatic tracking. Automatic tracking would upload the users meal without the participant having to log onto a website to manually input all the foods they have eaten. For instance, the participant's website account would be connected to his or her meal plan and would automatically input food as the participant purchased it at the dining hall. This feature would solve the major issues involved in tracking. Specifically, forgetfulness, tedium, and time concerns would be much less problematic, because users would not need to track meals eaten inside the dining halls. There are some potential obstacles to this method. For instance, it is possible that a participant would buy food that he or she did not eat, so the system would have to allow for some manual edits and additions. Finally, some features were used sparingly, such as the analysis feature. In the future, it would be useful to conduct focus groups to better understand how participants interact with our tool and why some features were not used.

Our interviewees provided many reasons for why participants may not have used the website, which could explain why only minor differences were found between our experimental groups and control group.

## DISCUSSION

## **Limitations**

As with any research project, we need to consider the potential limitations in the design of our study when attempting to generalize our results. Several factors could limit our study's external validity, including our participant recruitment methods, participant behavior during the study, and participant attrition before the end of testing.

The first factor that potentially limits the generalizability of our results to all college students is that we targeted only students eating at the university's dining halls. Therefore, our participant pool consisted of mostly freshmen and sophomores. In fact, there were only 58 upperclassmen in all of our research groups, compared to 154 underclassmen. While this disparity was necessary due to the technological constraints of the study, it means that our results are more externally applicable to underclassmen than to the college population as a whole. Additionally, our sample size was another limiting factor as the groups were not large enough to ensure that results were statistically significant.

Another possible limiting factor was volunteer bias. Due to the nature of such nutrition studies, students who were the most interested in their health may have been more likely to volunteer for our nutritional intervention than those who were less concerned. Therefore, we had a convenience sample rather than a randomized sample, which limits the generalizability of our results. We anticipated this distorting effect on the participant pool, and we attempted to reduce its influence by offering incentives for participation in the study. All potential recruits were offered two rewards to encourage them to sign up: a free water bottle awarded immediately after recruitment, and entry in a drawing to win a portable music player. These incentives were chosen because of their

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expected attractiveness to the entire student population. Even so, many potential recruits who declined our invitation to the study expressed lack of interest in the incentives. Many participants cited already having these objects as a reason not to participate. Despite the potential bias, we saw a wide range in self-efficacy regarding intake of fruits and vegetables and limited use of this website. Thus, this may not have been a limitation in this study.

A third possible limitation is our self-efficacy survey. It is possible that participants did not fully understand terms from the survey. For instance in the self-efficacy survey, the word “can” should be understood as “have access to” or “could if they wanted to.” If participants understood “can” to mean “have the desire to,” their results may have been inaccurate. Additionally, the email messages we sent out were aimed at improving students’ nutrition generally and were not completely tailored to fruits and vegetables. It is possible that the intervention improved students overall self-efficacy but not their self-efficacy regarding fruits and vegetables. Had we tailored our messages to more specifically address fruits and vegetables, we may have seen more of a difference in pre- and post-test scores between the experimental groups and control group.

Maturation is another phenomenon that can confound external validity. Over the course of a semester, participants’ eating habits might have altered as the students learned more about the options available to them. We expect that this effect would be strongest among the freshmen who participated in the study, as they were new to the University’s dining plan at the time they were recruited. At the beginning of the study, they may not have been familiar with the food options available in the dining halls, especially

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considering day-to-day menu changes. Over time, the freshmen would be expected to increase the variety of their choices as they learned about different options, and their patterns of consumption would gradually come to parallel those of more experienced students. As the semester progressed, students of all years could be expected to show some natural changes in dietary habits and level of comfort with dining hall eating. This maturation effect could lead to an improvement in self-efficacy that was not related to access to our website or email reminders.

Another limitation we considered was the potential inaccuracy of self-reported data. All of our demographic measures, such as height, weight, and birthday were self-reported. We attempted to control the quality of the data we collected by constraining possible inputs to reasonable ranges. For example, users selected their height on a sliding scale ranging only between 4.5 and 7.5 feet in order to decrease the possibility of receiving an incorrect response. In terms of diet reporting, the literature indicates that self-reported measures of fruit and vegetable intake are acceptably reliable, but that reliability increases when serving sizes are clarified (Nataranjan et al., 2006; Nataranjan et al., 2010). Therefore our website provided clear examples of serving sizes whenever the user reported a meal. Still, response bias could occur due to students' reluctance to report information that might be considered embarrassing or undesirable.

A final limitation that could affect the generalizability of the results is attrition. This is an inherent constraint on interventions that rely on self-reporting, because dietary reporting is time-consuming and demanding for participants. To counteract any tendency toward attrition, extensive effort was spent on making the website user-friendly, including a high degree of responsiveness to user feedback throughout the study and

## DISCUSSION

special attention paid to aesthetics and ease of use. For example, the DIET Tracker's searchable database of meals initially included only those foods that were served in campus dining halls. In response to user feedback, the types of meals that could be added were expanded to include data from grocery stores and restaurants on- and off-campus. By providing users the means to accurately report any kind of meal, we encouraged them to use the tool as much as possible. The email reminder experimental variable was conceived as a way to increase website usage and measure how increased usage might affect self-efficacy. Finally, the prompt to complete the post-test survey was sent repeatedly to all non-responders until a satisfactory number of surveys was completed, to counteract the natural tendency towards attrition.

Despite the extensive measures taken to retain users of the diet tracking software, participants could not be forced to self-report their dietary consumption, so many recruits used the tool very little or not at all. However, the set of participants who actually used the tool generally used it with great frequency. It seems that the most profound obstacle to studying a web-based tool's effect on college students' dietary self-efficacy is the students' willingness to use the tool.

### **Future Directions**

**Implications.** The results of our study suggest two main implications for nutrition interventions and research on dietary self-efficacy and intake. First of all, in accordance with the literature, gender was found to be the greatest predictor of website usage and change in self-efficacy. Therefore, future interventions need to be gender-conscious in their design and implementation. An intervention aimed at men should include features designed to attract men to the tool, and then provide incentives for continued tracking.

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Since women seem to be intrinsically motivated to use the tool more consistently, interventions targeting women should have features that capitalize on initial interest and help the user want to continue using the tool. One possible way to appeal to both genders could be to integrate the tool with social media and allow friend circles to share data, suggestions, and encouragement. The creation of this type of online presence could potentially help to overcome the forgetfulness and reluctance that our participants cited as barriers to tracking.

The second major implication deals with long-term website use. The initial appeal of diet tracking software is often high, but sustained use is low. Therefore, online interventions must not only attract first-time users, but also utilize an interface that encourages people to come back to the site. In our post-intervention interviews, we encountered several participants who either did not remember using the tool at all, or remembered using it but stated that they did not continue to track because they forgot. This suggests that one of the largest barriers to dietary awareness is the effort it takes to log meals. Interventions are likely to be more successful if they require minimal input from the participant, yet provide useful personalized information.

**Suggestions for future research.** The way in which we recruited participants almost certainly had an impact on our results. For this reason, it would be interesting to explore how different recruitment methods would change our results. Further research should recruit by targeting different groups (e.g. nutrition majors, physically active students, etc.) to see how students' interest or investment in personal health impacts their likelihood to track meals and improve self-efficacy. The same study on a larger scale would also be helpful, as it would allow researchers to draw conclusions about what

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proportion of the student body is most interested in a tracking tool. A larger study of this type, and the inclusion of multiple universities, would allow us to see whether our findings are true throughout the college student population. Some of our users indicated that tracking had an influence on their meal choices, so future studies could further investigate the relationship between use of an online tool and meal choices.

One of our major findings was that there was a difference in usage and self-efficacy by gender. We found that women used the tracking tool significantly more than men did. Also, self-efficacy change was significantly different among men and women in both studies. Further research should build on this finding and explore how gender affects both self-efficacy and website use. In particular, future studies should include more men than ours in order to allow the results to be generalized to a wider population.

Another of our major findings was that some students did not use the tracker because they forgot about it, or it took too much time to track each meal. Further research should explore whether making the process easier or less time-consuming affects students' knowledge and therefore their self-efficacy. This goal could be met by devising a way to automatically track foods by connecting the tracking website to the point-of-sale system in the dining hall. While this system would also have limitations and require participants to manually delete foods they did not actually eat, a majority of our participants said that they would be interested in an automatic tracking system. Therefore, it would be interesting to see if this automatic system would improve participants' self-efficacy. Additionally, it would be interesting to see whether a face to face meeting with a dietician would have increased participants use of the tool by providing accountability.

## DISCUSSION

Along these lines, further research is required to see whether making it easier to track meals by incorporating mobile access improves participants' desire and ability to track meals. We found that a surprisingly small number of our participants accessed the website from a mobile device, though many requested a smartphone application that could perform the same functions. This suggests that students wanted mobile access to the tool, but it was difficult to use the website on their mobile device. Further studies should examine the effects of smartphone applications, or a more navigable mobile version of the website, on participants' tracking behaviors. Additionally, further research could explore different ways of uploading meals, such as text message reporting or an application that recognizes food in photographs taken with a mobile phone.

Another direction for future studies would be to explore whether facilitating meal reporting would encourage more regular use of the tool. It would be interesting to see how using the tool affects the self-efficacy of individuals who are not motivated to self-report their meals, since self-reporting has already been shown to increase self-efficacy (Ha & Caine-Bish, 2009). Focus groups would be necessary to determine what incentive would be sufficient to overcome the reluctance of most college students to self-report.

Our website is very similar in functionality to the new USDA SuperTracker. Both tools offer personalization and allow users to track their meals, look up nutritional information, and graph a daily nutritional analysis. Our tool is simplified and tailored specifically to Maryland students, but the SuperTracker has many more features, such as a physical activity tracker and food group targets. In the future, our tool could incorporate some of these features.

## DISCUSSION

In order to make the results more generalizable, further research should expand the study to different populations. It would be interesting to see whether this kind of website affects adults, who have more ingrained habits, in different ways than it affects college students. This type of study would require a larger database including more proprietary nutritional data, such as that from restaurants and supermarket brands.

Finally, further research should investigate the effect of increased personalization, including goal-setting, tracking features, and social media integration. These features could potentially increase participants' motivation to track their diets, which could have an effect on their self-efficacy at the end of the study.

## **Conclusion**

Obesity is now one of the most significant health issues in America, and college students are at especially high risk for weight gain due to poor eating habits. The purpose of our study was to address the dietary behaviors of college students and determine whether there was a relationship between the use of a web-based dietary tracking tool and students' self-efficacy regarding eating fruits and vegetables. Although our website did not have a significant impact on self-efficacy as we had hypothesized, we found that there were significant changes by gender. Gender was the greatest predictor of website usage and changes in self-efficacy, which was consistent with prior literature. More research is needed to explore the effects of tailoring nutrition websites based on gender. To increase generalizability, further research should be conducted to expand the study to different populations. While previous research studies have used website interventions to focus on nutrition education, our website intervention for our study focused on the tracking habits of participants. It is our hope that the website nutrition intervention we created can be improved upon and adapted to other universities. In addition, we believe it would be worthwhile to study the effect of an automatic tracking tool on students' self-efficacy. A more thorough and accurate reporting tool could lead to higher self-efficacy, which should ultimately lead to better eating habits and improved overall health.

## **Appendix A**

### **Team DIET Timeline for Fall 2010-Spring 2013**

#### **Fall 2010**

- Develop research question and study design
- Review literature

#### **Spring 2011**

- Write and present thesis proposal
- Finalize surveys
- Identify experts to provide feedback
- Write and submit IRB application
- Review literature
- Apply for grants and develop a budget
- Design team website
- Pilot test to identify flaws in execution of methodology

#### **Fall 2011**

- Recruit participants
- Begin phase 1 data collection
- Implement intervention according to design over the course of the semester
- Continue updating team website
- Develop outline of thesis chapters
- Continue to review literature to draft chapters one and two of thesis paper

**Spring 2012**

- Revise methodology using insight from Fall 2011, focusing on recruitment strategies, website design/use, and intervention method
- Begin phase 2 data collection
- Begin analysis of Fall 2011 data
- Draft first three chapters of thesis and get feedback from mentors and librarian
- Make revisions to thesis draft
- Prepare for and present at undergraduate research day

**Fall 2012**

- Complete data analysis
- Draft chapters four and five of thesis and complete full draft
- Prepare presentation for Team Thesis Conference Rehearsal scheduled for February
- Identify at least five experts who have agreed to be reviewers/discussants at the thesis conference

**Spring 2013**

- Submit final team information to Gemstone staff
- Complete and submit completed thesis draft
- Present and defend thesis at Team Thesis Conference
- Revise and submit final thesis including the final thesis submission form completed by mentors
- Present at Experimental Biology 2013 Conference in Boston, Massachusetts

## Appendix B

### Informed Consent

<b>Project Title</b>	<i>The Effect of Web-Based Self-Reporting on College Students' Diets and Self-Efficacy</i>
<b>Purpose of the Study</b>	<i>This is a research project being conducted by Team Dietary Information Evaluation Technologies (DIET) of the Gemstone program at the University of Maryland, College Park. We are inviting you to participate in this research project because you currently are a member of the group that is of interest to our study: non-athlete freshman or sophomore residing on campus with a meal plan. The purpose of this research project is to compare your reported intake to your spending at the University of Maryland's dining halls and measure any change in your self-efficacy using a pretest and posttest survey.</i>
<b>Procedures</b>	<p><i>During the recruitment stage, you will be asked to complete a <u>Demographic Survey</u> that will ask various questions concerning demographic information, residency status, dining plan, and physical activity level. This survey will take no longer than fifteen minutes. You will be entered into a raffle for an iPod Touch.</i></p> <p><i>After recruitment, you will be asked to complete an online <u>Eating Aptitude Test (EAT)</u> that will screen for eating disorders, determine how often the student eats off campus, and assess your general physical activity level. This test will take approximately twenty to thirty minutes. If you do not pass the EAT screening, you will be notified of the test's recommendation to seek advice from a medical professional.</i></p> <p><i>If you pass the EAT, you will be invited to participate in our 8-week intervention study. The intervention will involve you creating an account on our website, self-reporting your daily intake, and completing an online <u>Self-Efficacy Survey</u> tailored specifically for the consumption of fruits and vegetables once at the beginning of study and again at the end of the study. The survey will take no longer than twenty minutes.</i></p>
<b>Potential Risks and Discomforts</b>	<i>There may be some risks from participating in this research study. You may experience some discomfort about reporting your daily intake. Risks may also arise from the potential for the loss/breach of confidentiality.</i>

<b>Potential Benefits</b>	<p><i>There are no direct benefits to you. However, possible benefits include the fact that this study may help you understand and improve your diet. We hope that, in the future, other people might benefit from this study through improved understanding of how college students interact with online nutritional tracking systems and the effects of such systems on their self-efficacy in regard to eating a healthy diet. Results from this study may also contribute to scientific knowledge about the validity of web-based self-reporting.</i></p>
<b>Confidentiality</b>	<p><i>Any potential loss of confidentiality will be minimized by storing all codes and data in a password protected computer/server that is kept secure. Access to our website will be protected by the Central Authentication System (CAS). Data access is limited to the Principal Investigator and researchers working directly on this project.</i></p> <p><i>If we write a report or article about this research project, your identity will be protected to the maximum extent possible. Your information may be shared with representatives of the University of Maryland, College Park or governmental authorities if you or someone else is in danger or if we are required to do so by law.</i></p> <p><i>In accordance with legal requirements and/or professional standards, we will disclose to the appropriate individuals and/or authorities information that comes to our attention concerning eating disorders or potential harm to you or others.</i></p>
<b>Right to Withdraw and Questions</b>	<p><i>Your participation in this research is completely voluntary. You may choose not to take part at all. If you decide to participate in this research, you may stop participating at any time. If you decide not to participate in this study or if you stop participating at any time, you will not be penalized or lose any benefits to which you otherwise qualify. If you are an employee or student, your employment status or academic standing at UMD will not be affected by your participation or non-participation in this study.</i></p> <p><i>If you decide to stop taking part in the study, if you have questions, concerns, or complaints, or if you need to report an injury related to the research, please contact the investigator, Dr. Nadine R. Sahyoun at: 0112 Skinner Building, 301-405-8774, <a href="mailto:nsahyoun@umd.edu">nsahyoun@umd.edu</a>.</i></p>



<b>Participant Rights</b>	<p><i>If you have questions about your rights as a research participant or wish to report a research-related injury, please contact:</i></p> <p style="text-align: center;"><b>University of Maryland College Park Institutional Review Board Office 1204 Marie Mount College Park, Maryland, 20742 E-mail: <a href="mailto:irb@umd.edu">irb@umd.edu</a> Telephone: 301-405-0678</b></p> <p><i>This research has been reviewed according to the University of Maryland, College Park IRB procedures for research involving human subjects.</i></p>
<b>Statement of Consent</b>	<p><i>Your signature indicates that you are at least 18 years of age; you have read this consent form or have had it read to you; your questions have been answered to your satisfaction and you voluntarily agree to participate in this research study. You will receive a copy of this signed consent form.</i></p> <p><i>You may print a copy of this consent form. If you agree to participate, please click "I Agree/Consent" below.</i></p>
<b>Signature and Date</b>	<b>I Agree/Consent</b>

## Appendix C

### Eating Attitudes Test (EAT-26)

**Check a response for each of the following statements:**

1. Am terrified about being overweight.
  - Always
  - Usually
  - Often
  - Sometimes
  - Rarely
  - Never
2. Avoid eating when I am hungry.
  - Always
  - Usually
  - Often
  - Sometimes
  - Rarely
  - Never
3. Find myself preoccupied with food.
  - Always
  - Usually
  - Often
  - Sometimes
  - Rarely
  - Never
4. Have gone on eating binges where I feel that I may not be able to stop.
  - Always
  - Usually
  - Often
  - Sometimes
  - Rarely
  - Never
5. Cut my food into small pieces.
  - Always
  - Usually
  - Often
  - Sometimes
  - Rarely
  - Never

6. Aware of the calorie content of the foods that I eat.
  - Always
  - Usually
  - Often
  - Sometimes
  - Rarely
  - Never
7. Particularly avoid food with a high carbohydrate content (i.e. bread, rice, potatoes etc.)
  - Always
  - Usually
  - Often
  - Sometimes
  - Rarely
  - Never
8. Feel that others would prefer if I ate more.
  - Always
  - Usually
  - Often
  - Sometimes
  - Rarely
  - Never
9. Vomit after I have eaten.
  - Always
  - Usually
  - Often
  - Sometimes
  - Rarely
  - Never
10. Feel extremely guilty after eating.
  - Always
  - Usually
  - Often
  - Sometimes
  - Rarely
  - Never
11. Am preoccupied with a desire to be thinner.
  - Always
  - Usually
  - Often
  - Sometimes
  - Rarely
  - Never

12. Think about burning calories up when I exercise.
- Always
  - Usually
  - Often
  - Sometimes
  - Rarely
  - Never
13. Other people think I am too thin.
- Always
  - Usually
  - Often
  - Sometimes
  - Rarely
  - Never
14. Am preoccupied with the thought of having fat on my body.
- Always
  - Usually
  - Often
  - Sometimes
  - Rarely
  - Never
15. Take longer than others to eat my meals.
- Always
  - Usually
  - Often
  - Sometimes
  - Rarely
  - Never
16. Avoid foods with sugar in them.
- Always
  - Usually
  - Often
  - Sometimes
  - Rarely
  - Never
17. Eat diet foods.
- Always
  - Usually
  - Often
  - Sometimes
  - Rarely
  - Never

18. Feel that food controls my life.
- Always
  - Usually
  - Often
  - Sometimes
  - Rarely
  - Never
19. Display self-control around food.
- Always
  - Usually
  - Often
  - Sometimes
  - Rarely
  - Never
20. Feel that others pressure me to eat.
- Always
  - Usually
  - Often
  - Sometimes
  - Rarely
  - Never
21. Give too much time and thought to food.
- Always
  - Usually
  - Often
  - Sometimes
  - Rarely
  - Never
22. Feel uncomfortable after eating sweets.
- Always
  - Usually
  - Often
  - Sometimes
  - Rarely
  - Never
23. Engage in dieting behavior.
- Always
  - Usually
  - Often
  - Sometimes
  - Rarely
  - Never

24. Like my stomach to be empty.
- Always
  - Usually
  - Often
  - Sometimes
  - Rarely
  - Never
25. Have the impulse to vomit after meals.
- Always
  - Usually
  - Often
  - Sometimes
  - Rarely
  - Never
26. Enjoy trying new rich foods.
- Always
  - Usually
  - Often
  - Sometimes
  - Rarely
  - Never

**In the past 6 months have you:**

- A. Gone on eating binges where you feel that you may not be able to stop?
- Never
  - Once a month or less
  - 2-3 times a month
  - Once a week
  - 2-6 times a week
  - Once a day or more
- B. Ever made yourself sick (vomited) to control your weight or shape?
- Never
  - Once a month or less
  - 2-3 times a month
  - Once a week
  - 2-6 times a week
  - Once a day or more
- C. Ever used laxatives, diet pills or diuretics (water pills) to control your weight or shape?
- Never
  - Once a month or less
  - 2-3 times a month
  - Once a week
  - 2-6 times a week
  - Once a day or more

- D. Exercised more than 60 minutes a day to lose or to control your weight?
- Never
  - Once a month or less
  - 2-3 times a month
  - Once a week
  - 2-6 times a week
  - Once a day or more
- E. Lost 20 or more pounds in the last 6 months?
- Yes
  - No

## Appendix D

### IRB Inclusions

Recruitment flyers and scripts, Fall nutrition email messages

## RESEARCH PARTICIPANTS NEEDED

### For a Nutrition and Self-Efficacy Research Study

- *Are you at least 18 years old?*
- *Do you have a dining plan?*
- *Do you eat most of your meals at the Diner?*

If you answered YES to these questions, you may be eligible to participate in a nutrition research study. Students will take an online survey to determine eligibility. All participants will be entered into a raffle to win an iPod Nano!



Study is conducted by Team DIET  
Gemstone Honors Program, University of Maryland  
For more information, email [teamdietumd@gmail.com](mailto:teamdietumd@gmail.com)

**To take the survey, go to [ter.ps/dietpretest](http://ter.ps/dietpretest)**

*Figure D 1.* Flyer given to participants and circulated around campus to advertise the study.



### Script for In-Person Recruitment

- Hello! My name is \_\_\_\_\_ and I'm part of Team DIET, a Gemstone team here at the University of Maryland. As part of our team project, we have developed a website that will help you keep track of your nutrition, and we need students like you to try it out! Are you interested in being enrolled to use a free tool that helps you track your eating habits here at the North Campus Diner? Your participation would help us collect data for a research project, so we are offering an exciting incentive to all who enroll!
- It works like this: after you complete a brief survey, we will determine whether you are eligible to participate in our study. You will then be given access to our website, where you can log on 24 hours a day to see a personalized summary of what you have eaten here, and a nutritional analysis of the foods you choose. This way, you will be able to easily keep up-to-date on your eating habits just by checking our fun interactive website.
- As a participant, you may receive periodic emails from our Team. They will not be every day and there will never be more than one in a day.
- Disclaimer: Our dietary recommendations are based on current scientific research and standards set by the U.S. Department of Agriculture. That said, we are not physicians or nutritional experts. Furthermore, our tool is only as good as the input it receives. It is in the beta-testing stage of development, so you may experience bugs or inaccuracies in your dietary analysis. Therefore, you should not consider advice from the tool to be an expert opinion. If you have special dietary needs, always follow your physician's advice.

**Script for Recruitment during Intro Classes (UNIV100, HONR100, etc.)**

Want help avoiding the dreaded “freshman 15”? Eating a balanced diet defined by the USDA food pyramid has been shown by studies to have many health benefits. Team DIET, an undergraduate Gemstone research team here at the University of Maryland is conducting a nutrition study on freshman students living on North Campus who eat a majority of their meals at the North Campus diner. Sign up to participate if you’re interested in having access to an online food tracking tool to maintain a healthy diet, or if you’d like the chance to win a prize in the raffle at the end of the study! Contact Team DIET at [teamdietumd@gmail.com](mailto:teamdietumd@gmail.com) for more information!

**Recruitment Script through Email Listservs**

Gemstone Team DIET is currently recruiting participants for a nutrition and self-efficacy research study. Participants MUST be at least 18 years old, have a dining plan, and eat most of their meals at the Diner. Participants will take an online survey to determine eligibility ([ter.ps/dietpretest](http://ter.ps/dietpretest)). All participants will be entered into a raffle to win an iPod Touch. If you are interested or would like more information, email [teamdietumd@gmail.com](mailto:teamdietumd@gmail.com).

**Fall 2011 Nutrition Tip Emails**

1. Cutting back on saturated fatty acids by purchasing fat-free or low-fat milk or decreasing consumption of items such as full-fat cheese, pizza, sausage, bacon and ribs can reduce the risk of incurring cardiovascular disease later in life.
2. “Added sugars contribute an average of 16 percent of the total calories in American diets.” Major sources of added sugars include soda, sports drinks and energy drinks. Replacing these with water more often will lower the overall calorie intake of the diet without compromising intake of nutrients.
3. Replace refined grains (white bread, white flour products) with whole grain products. Refined grains lose most of their nutrients during the refining process and also tend to be high in sugar. Try a sandwich on whole wheat bread instead of on white bread or a sub roll, or a wrap with a whole grain tortilla. Grilled whole grain wraps from Sprouts are yummy and a good alternative to regular flour tortilla wraps.
4. Having a balanced intake of protein (not too much, not too little) is an important aspect of healthy eating. The CDC recommends 46 g of proteins daily for women and girls ages 14-70+ and 52-56 g for men and boys ages 14-70+. Good sources of protein include meats, poultry, fish, tofu, beans and peas, eggs, milk products and others.
5. To make lower-fat protein choices in your diet, trim visible fat from meat and remove the skin from turkey or chicken. Go vegetarian and substitute black or pinto beans for meat in tacos, or substitute tofu for beef in stir-fry. You can also switch to low-fat or fat-free milk, yogurt and cheese.

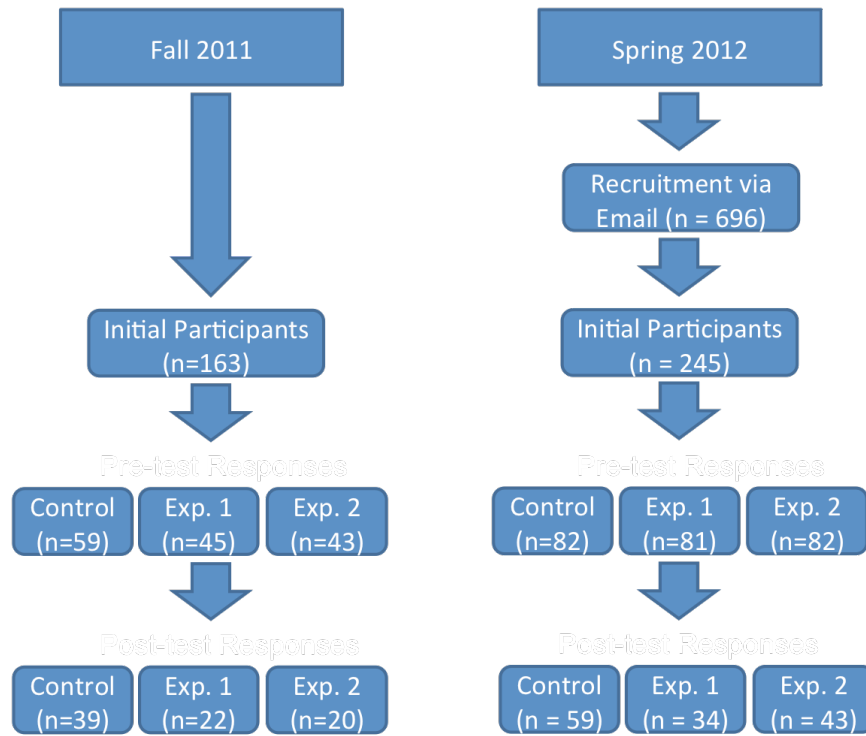
6. To get your daily recommended intake of fiber, and knock out servings of fruits and veggies at the same time, choose whole fruits over juice, have another serving of vegetables with dinner, choose whole grains and keep things like celery, cucumbers or carrots with hummus from the salad bar in your mini fridge for snacking on.
7. Getting enough potassium in your diet can help counteract the effects of getting too much sodium, including preventing or lowering high blood pressure. Some sources of potassium include leafy greens (think spinach), vine fruits (grapes and blackberries), root vegetables (carrots and potatoes), citrus fruits (oranges and grapefruits), and the ever-popular banana. Plain yogurt is also a good source of potassium.
8. Make healthier drink choices by forgoing high fat milk or beverages with sugar added throughout the day. A small latte (12 oz.) with skim milk has about 125 calories, while a medium latte (16 oz.) with whole milk has about 265 calories. A 20 oz soda with lunch may have 227 calories and be high in sugar, while water or diet soda each contributes zero calories to your daily intake.
9. Did you know that the prevalence of obesity for Americans ages 12-19 years old tripled from 6% to 18% from the late 1970s to 2008? Adults followed a similar pattern, with the prevalence of obesity more than doubling from 15% to 34% in the same time period. According to the USDA, the most effective ways to prevent weight gain are controlling total caloric intake through foods and beverages and increasing physical activity.

10. Did you know that “moderate evidence shows that adults who eat more whole grains, particularly those higher in dietary fiber, have a lower body weight compared to adults who eat fewer whole grains?” Some examples of foods with whole grains are whole-wheat flour, oatmeal, whole cornmeal, and brown rice. Some foods like white bread, white rice, and white flour have been refined, removing much of the dietary fiber.
11. Most dietary sodium comes from salt added during food processing. According to the USDA, “Virtually all Americans consume more sodium than they need.” Some ways to reduce sodium include: eating more fresh foods, fewer processed foods, and reading the Nutrition Facts label for information on sodium content and purchase foods low in sodium.
12. Did you know that a number of studies found an association between increased trans fatty acid (transfat) intake and increased risk of cardiovascular disease? According to the USDA, Americans should keep their intake of trans fatty acids as low as possible.
13. Most vegetables and fruits are major contributors of a number of nutrients that are underconsumed in the United States, including folate, magnesium, potassium, dietary fiber, and vitamins A, C, and K.” The USDA advocates eating a variety of vegetables, especially dark-green, red, and orange vegetables, as well as beans and peas.
14. Did you know that consumption of about 8 ounces per week of a variety of seafood could contribute to the prevention of heart disease? The USDA recommends eating seafood for its DHA and EPA content. In addition, the health benefits from consuming a variety of seafood in the amounts recommended outweigh the risks associated with methyl mercury found in some seafood in varying levels.

15. Calcium is important for optimal bone health. In addition, “calcium serves vital roles in nerve transmission, constriction and dilation of blood vessels, and muscle contraction.” Milk products contribute significantly to calcium intake. According to the USDA, though calcium in some plant foods is well absorbed, removing milk products from the diet requires careful replacement with other food sources including fortified foods. Consuming enough plant foods may be “unrealistic for many”.
16. According to the USDA, overconsumption of alcohol over time is associated with weight gain. Also, the caloric content of any mixture consumed with the alcohol must be accounted for when calculating content. Reducing alcoholic intake is “a strategy that can be used by adults to consume fewer calories.”

## Appendix E

### Participant Recruitment Flowchart



*Figure E 1.* Flowchart showing the numbers of participants recruited, how many of these recruits activated their accounts, and how these participants were sorted into experimental groups.



**Appendix F**  
**Self-Efficacy Survey**

Name: \_\_\_\_\_ UID: \_\_\_\_\_

Email: \_\_\_\_\_ Phone Number: \_\_\_\_\_

---

Please rate each of the following statements on a scale of 1 to 5.

1 – Not at all confident

2 – Not confident

3 – Neither confident nor not confident

4 – Confident

5 – Very confident

To what extent do you feel confident that you:

Can have fruits and vegetables when in a rush	1	2	3	4	5
Can eat fruit as part of lunch most days	1	2	3	4	5
Can have fruits and vegetables when feeling tired	1	2	3	4	5
Can get fruit when eating away from home	1	2	3	4	5
Can have extra vegetables at dinner	1	2	3	4	5
Can have a vegetable for dinner most days	1	2	3	4	5
Can eat five servings of fruits and vegetables most days	1	2	3	4	5
Can order at least one vegetable dish at a restaurant	1	2	3	4	5
Can eat other fruits and vegetables when favorites are not available	1	2	3	4	5

## Appendix G

### DIET Tracker Usability Survey

#### Administered online

*Please rate the DIET Tracker on the following criteria:*

- 1 – Poor on this dimension
- 2 – Mostly poor on this dimension
- 3 – Slightly poor on this dimension
- 4 – Neither poor nor good on this dimension
- 5 – Slightly good on this dimension
- 6 – Mostly good on this dimension
- 7 – Excellent on this dimension

The DIET Tracker:

Was sufficiently easy to use	1	2	3	4	5	6	7
Allows a variety of foods to be searched for	1	2	3	4	5	6	7
Provides sufficient information on the foods at the UMD Dining Halls	1	2	3	4	5	6	7

How frequently did you read email messages from the DIET Tracker?

- Multiple times per week
- Once a week
- Once every 2 weeks
- Once a month
- Never

To what extent did the weekly email messages influence your dietary choices?

1 = Had no Influence, 7 = Strongly Influenced

1	2	3	4	5	6	7
---	---	---	---	---	---	---

*Please choose the response that best reflects your opinion of the DIET Tracker*

I would like to use the DIET Tracker in the future.

1 = Strongly Disagree, 7 = Strongly Agree

1	2	3	4	5	6	7
---	---	---	---	---	---	---

The process of adding a meal was

1 = Confusing, 7 = Clear

1	2	3	4	5	6	7
---	---	---	---	---	---	---

What functions of the DIET Tracker did you use?

*Choose all that apply.*

- Calendar feature
- "Add a new meal" feature
- "Favorite meal" feature
- Searching the food database
- Adding custom foods
- Feedback and Support Tab
- Tutorial Videos on the "Help" Page
- Analysis
- Other: \_\_\_\_\_

Have you accessed the DIET Tracker on your mobile device's browser?

- Yes
- No

Would you recommend the DIET Tracker to a friend?

- Yes
- No

Describe what you like about the DIET Tracker. (Open-ended)

Describe what you dislike about the DIET Tracker. (Open-ended)

How frequently did you use the DIET Tracker?

- Daily
- 3-4 times per week
- 1-2 times per week
- 1-2 times per month
- Never

What were some reasons that you chose to use the DIET Tracker?

*Choose all that apply*

- Concern for personal health/nutrition
- Curiosity about nutritional content of foods
- Convenience
- The possibility of incentives provided by the study
- To contribute to the research study
- N/A
- Other: \_\_\_\_\_

What were some reasons that you chose NOT to use the DIET Tracker regularly?

*Choose all that apply*

- Took too much time
- Technical issues with the DIET Tracker
- Forgetfulness
- Tool was not useful
- No desire to track my diet
- N/A
- Other: \_\_\_\_\_

#### *Future Directions of the DIET Tracker*

I would be more likely to use the DIET Tracker if it could automatically track what foods I ate at the UMD Dining Halls.

1 = Strongly Disagree, 7 = Strongly Agree

1	2	3	4	5	6	7
---	---	---	---	---	---	---

How highly would you value an app that automatically tracked the foods you ate at the UMD Dining Halls?

*\*Automatic tracking might occur when you use your student ID card to pay for food at the UMD Dining Halls. The meal's nutritional information would then be saved to your DIET Tracker account IN REAL TIME. All current DIET Tracker usability would still be present.*

- less than \$0.99
- \$0.99
- \$1.99
- \$2.99
- \$3.99
- \$4.99
- more than \$4.99
- N/A - I would not want this feature

What other features would you like to see on the DIET Tracker so that you can more easily monitor your nutrition? (Open-ended)

*Please be as specific as possible.*

If Team DIET conducts future research on the DIET Tracker, would you be willing to participate?

*\*Future research may include other incentives provided by Team DIET. This would help us improve the DIET Tracker and make it a tool that all UMD students can use.*

- Yes
- No

## Appendix H

### Phone Interview Questions

1. What was your overall impression of the experience? What did you think of the site?
2. Why did you choose to use or not use the website?
3. Have you ever used a similar tool? If yes, how do they compare?
4. Did anyone have any problems using the website? How could we improve it?
5. How were these problems addressed? Did you like the feedback?
6. What was your favorite aspect of the website?
7. How did the website influence your decisions about what you ate? (Confidence level)
8. How much more likely are you to use our website vs. another online tool?
9. Would you recommend a tool like this to friends at other universities? Why or why not?
10. Did the email reminders influence how frequently you used the tool?
11. Did the nutrition tips influence your dietary choices?
12. How do you think we could make our tool more attractive to new users?
13. Do you think this website would affect self-efficacy? Positively or negatively? Why?

## Appendix I

### Website Design and Use Flowchart



Figure I 1. Flowchart explaining the relationship between different pages on the website. The chart depicts how a user might navigate the site and see their tracking information.

## Appendix J

## Fall 2011 Web Application Screenshots

Team DIET

Successfully created meal.

Meal details for Thursday, October 13 [Add new](#) | [View all](#)

**Daily Totals**

Calories: **945** (Max: 2000\*)

Sodium: **1084mg** (Max: 2400mg\*)

**2** Fruits and Vegetables

Fats: **39g** (Max: 65g\*)

Sugar: **52g** (Max: 40g\*)

\*Try to stay green! Badges in red mean you're above your Daily Value (DV) for this item (based on a 2000 calorie diet). Green means you're under your Daily Value (DV).

Morning Morning Afternoon **Evening** [Create new meal using the food\(s\) below](#) | [Edit](#) | [Delete](#)

When you were at the North Campus Diner, you ate:

**Garden Cheeseburger (UMD)**

<b>Nutrition Facts</b>	<b>Amount/Serving</b>	<b>%DV**</b>	<b>Amount/Serving</b>	<b>%DV**</b>
Serving Size 1 EACH*				
Servings eaten 1.0	<b>Total Fat</b> 11g	<b>17%</b>	<b>Total Carbs</b> 40g	<b>13%</b>
<b>Calories 386</b>	Sat. Fats 4g	<b>20%</b>	Dietary Fiber 9g	<b>38%</b>
Calories from Fat 99	<b>Cholesterol</b> 10mg	<b>3%</b>	Sugars 5g	<b>12%</b>
*Nutritional information provided by UMD Dining Services.	<b>Sodium</b> 104mg	<b>4%</b>	<b>Protein</b> 28g	<b>56%</b>
**Based on a 2000-calorie diet.	<b>Calcium</b> 24mg			

The nutrient composition of food may vary due to: genetic, environmental and processing variables; changes in the manufacturer's product formulation; and cooking and preparation techniques.

The information Team DIET and/or UMD Dining provides should be considered as approximations of the nutritional analysis menu items.

Figure J 1. Screenshot depicting the page that Fall 2011 participants saw after they successfully tracked a meal. The page shows the nutrition information for the different foods logged as well as badges representing daily totals. These badges remained green while the participant was under the recommended intake and turned red if the participant exceeded it.





Click on the date to add a new meal

< October 2011 >

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
25 add Calories: 150 Sodium: 54mg Fats: 9g Sugar: 7g	26 add Calories: 250 Sodium: 4450mg Fats: 0g Sugar: 15g	27 add	28 add Calories: 2800 Sodium: 260mg Fats: 20g Sugar: 0g	29 add	30 add Calories: 1170 Sodium: 1560mg Fats: 66g Sugar: 46g	1 add
2 add	3 add Calories: 563 Sodium: 678mg Fats: 31g Sugar: 25g	4 add Calories: 1086 Sodium: 395mg Fats: 45g Sugar: 73g	5 add Calories: 207 Sodium: 147mg Fats: 7g Sugar: 17g	6 add Calories: 360 Sodium: 799mg Fats: 23g Sugar: 0g	7 add	8 add Calories: 4000 Sodium: 1060mg Fats: 160g Sugar: 0g
9 add	10 add Calories: 2810 Sodium: 5670mg Fats: 180g Sugar: 200g	11 add	12 add Calories: 2800 Sodium: 260mg Fats: 20g Sugar: 0g	13 add Calories: 945 Sodium: 1084mg Fats: 39g Sugar: 52g	14 add Calories: 4000 Sodium: 1060mg Fats: 160g Sugar: 0g	15 add Calories: 250 Sodium: 4450mg Fats: 0g Sugar: 15g
16 add Calories: 2548 Sodium: 763mg Fats: 98g Sugar: 30g	17 add Calories: 1170 Sodium: 1560mg Fats: 66g Sugar: 46g	18 add Calories: 281 Sodium: 567mg Fats: 18g Sugar: 20g	19 add Calories: 185 Sodium: 3293mg Fats: 0g Sugar: 11g	20 add	21 add Calories: 208 Sodium: 279mg Fats: 3g Sugar: 6g	22 add
23 add Calories: 1170 Sodium: 1728mg Fats: 30g Sugar: 104g	24 add Calories: 360 Sodium: 799mg Fats: 23g Sugar: 0g	25 add Calories: 4000 Sodium: 1060mg Fats: 160g Sugar: 0g	26 add	27 add Calories: 2985 Sodium: 3553mg Fats: 20g Sugar: 11g	28 add Calories: 1269 Sodium: 2811mg Fats: 27g Sugar: 39g	29 add Calories: 157 Sodium: 117mg Fats: 8g Sugar: 8g
30 add	31 add	1 add Calories: 185 Sodium: 3293mg Fats: 0g Sugar: 11g	2 add Calories: 2949 Sodium: 1416mg Fats: 145g Sugar: 294g	3 add Calories: 150 Sodium: 54mg Fats: 9g Sugar: 7g	4 add	5 add

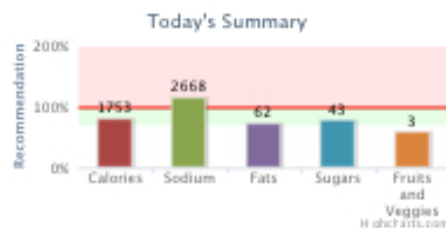
Figure J 2. Screenshot of the participant's home page calendar during the Fall 2011 study. The calendar allowed the participant to view the daily totals of each day tracked in the month. Red badges indicate that the participant exceeded the recommended intake, whereas green badges indicate the participant remained under the recommended intake.

## Appendix K

## Spring 2012 Web Application Screenshots

**Tuesday,  
January 8**

[Edit](#) [Delete](#)



- Raisin Bran Muffin (UMD)

Calories: 377 Sodium: 516mg

Fats: 16g Sugar: 30g

Nutrition Facts			
Calories 377		Calories from Fat 143	
Serving size: 1 EACH		Serving(s) eaten: 1.0	
Amount/Serving	%DV	Amount/Serving	%DV
Total Fat 16g	19%	Total Carbs 56g	19%
Sat. Fats 0g	0%	Dietary Fiber 0g	0%
Cholesterol 40mg	13%	Sugars 30g	54%
Sodium 516mg	22%	Protein 6g	9%

› Garden Cheeseburger (UMD)

Calories: 386 Sodium: 1040mg

Fats: 12g Sugar: 5g

› Feijoada Soup (UMD)

Calories: 960 Sodium: 1056mg

Fats: 34g Sugar: 9g

› Whole Baby Carrots (UMD)

Calories: 30 Sodium: 66mg

Fats: 0g Sugar: 0g

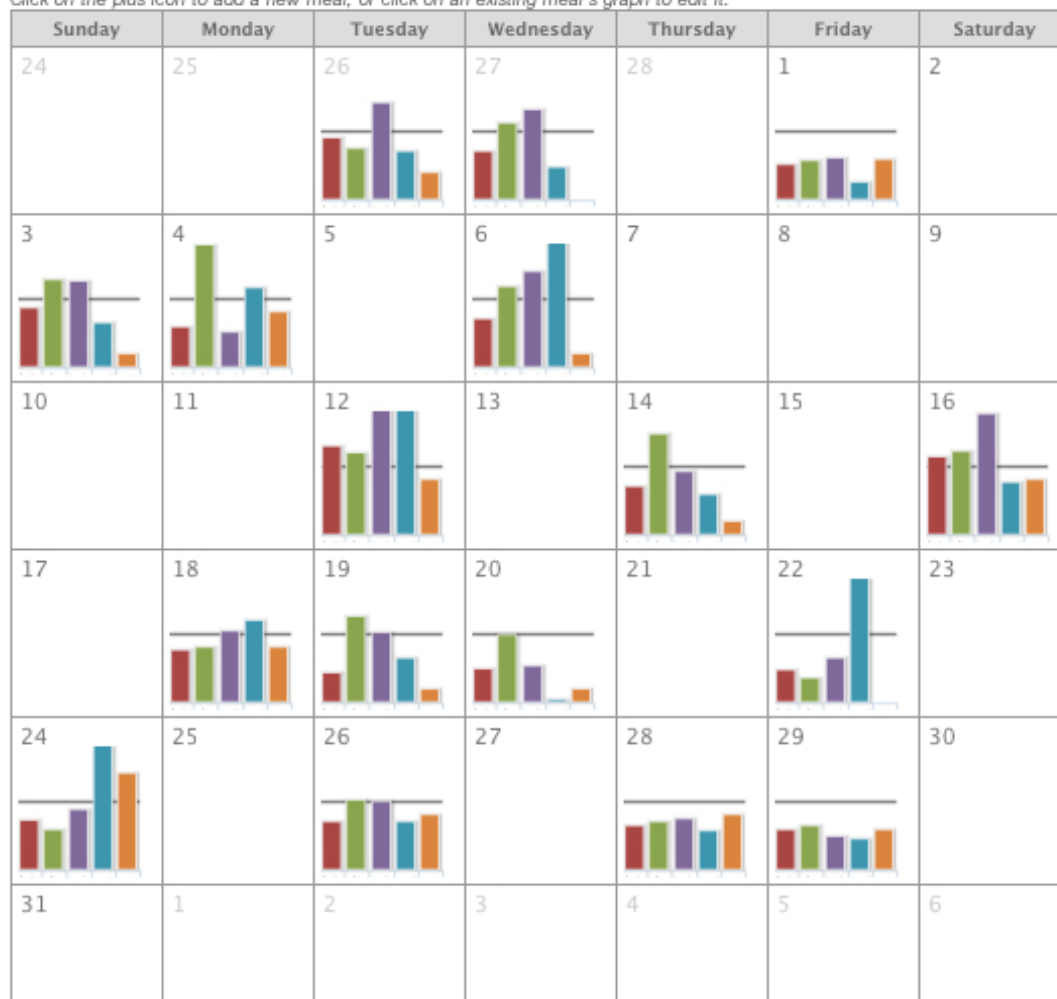
The nutrient composition of food may vary due to genetic, environmental and processing variables; changes in the manufacturer's product formulation; and/or cooking and preparation techniques.

The information Team DIET and/or UMD Dining provides should be considered as approximations of the nutritional analysis menu items.

*Figure K 1.* Screenshot of the page that Spring 2012 participants saw after they successfully logged a meal. The nutrition information is similar to that seen by the Fall 2011 participants. However, the daily total badges were replaced by a summary graph that gave participants a more holistic and positive view of their habits. Instead of turning red when a participant exceeded the recommended intake, this graph allowed participants to view their intake as a percentage of the recommended amount.

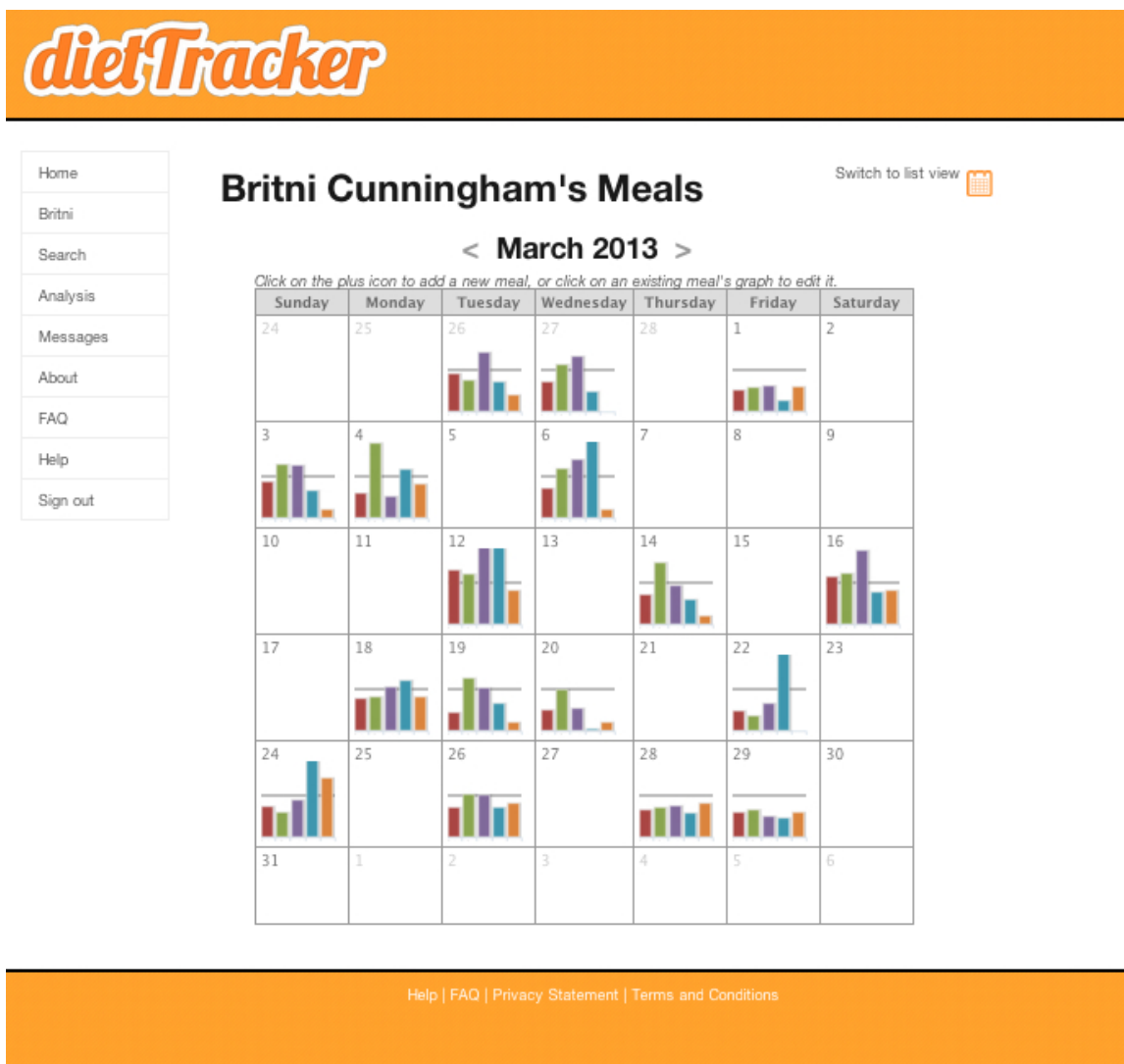
## &lt; March 2013 &gt;

Click on the plus icon to add a new meal, or click on an existing meal's graph to edit it.



[Help](#) | [FAQ](#) | [Privacy Statement](#) | [Terms and Conditions](#)

*Figure K 2.* Screenshot of the participant's home page calendar during the Spring 2012 study. The calendar allowed the participant to view the daily totals of each day tracked in the month. Instead of badges, the calendar depicted the summary graph for each day, allowing participants to see their intake as a percentage of the recommended intake.



*Figure K 3.* Screenshot of the homepage that a participant would view after activating his or her account and logging into the website.

**dietTracker**

Home  
Britni  
Search  
Analysis  
Messages  
About  
FAQ  
Help  
Sign out

**Britni Cunningham's Meals**

Switch to calendar view

< **March 2013** >

**This Month's Meals**

- Sunday, Mar 11
- Friday, Mar 01
- Sunday, Mar 03
- Monday, Mar 04
- Wednesday, Mar 06
- Tuesday, Mar 12
- Thursday, Mar 14
- Saturday, Mar 16
- Monday, Mar 18
- Tuesday, Mar 19
- Wednesday, Mar 20
- Friday, Mar 22
- Sunday, Mar 24
- Tuesday, Mar 26
- Thursday, Mar 28
- Friday, Mar 29

**Favorite Meals**

- Meal 17
- Meal 1
- Meal 6
- Meal 8
- Meal 3
- Meal 4
- Meal 2
- Meal 11
- Meal 13
- Meal 15
- Meal 5
- Meal 16
- Meal 10
- Meal 9
- Meal 12
- Meal 14
- Meal 7

Add a new meal: +

*Figure K 4.* Screenshot of an alternate viewing option for the homepage. Instead of viewing the calendar, participants could choose to view their monthly meals in a form of a list of days on which meals were created. Additionally, this page allowed the participant to view meals they had designated as a favorite.

**dietTracker**

Home  
Britni  
Search  
Analysis  
Messages  
About  
FAQ  
Help  
Sign out

## Britni Cunningham's Profile

Search the database    Add a new custom food    See the foods you've added

### Email reminder options

Emails will be sent around 7 p.m. on the day you've chosen.

Sunday  
 Monday  
 Tuesday  
 Wednesday  
 Thursday  
 Friday  
 Saturday

### Activity Level

Enter your activity level for more personalized nutritional goals.

**Moderately Active** ▾

Your current recommended calories are 2200.0

### Email Address

Update your email address to stay in touch

**Update**

### More about activity levels:

**Sedentary** a lifestyle that includes only the light physical activity associated with typical day-to-day life.

**Moderately Active** a lifestyle that includes physical activity equivalent to walking about 1.5 to 3 miles per day at 3 to 4 miles per hour, in addition to the light physical activity associated with typical day-to-day life.

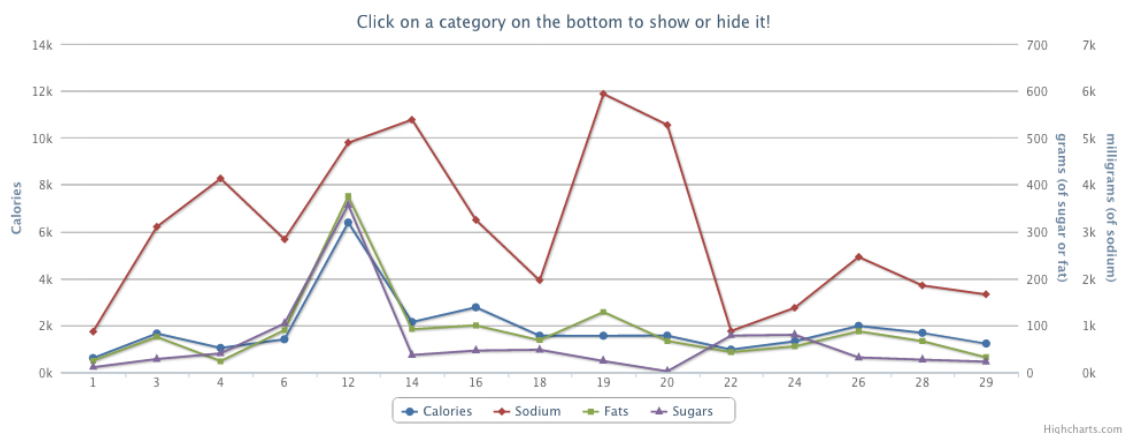
**Active** a lifestyle that includes physical activity equivalent to walking more than 3 miles per day at 3 to 4 miles per hour, in addition to the light physical activity associated with typical day-to-day life

This data is based on Estimated Energy Requirements (EER) equations, using reference heights (average) and reference weights (healthy) for each age-gender group. For adults, the reference man is 5 feet 10 inches tall and weighs 154 pounds. The reference woman is 5 feet 4 inches tall and weighs 126 pounds. EER equations are from the Institute of Medicine. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids. Washington (DC): The National Academies Press; 2002.

*Figure K 5.* Screenshot of the participant's profile page. This page allowed participants to set their preferences for reminder emails, add their average activity level, and update their email address.

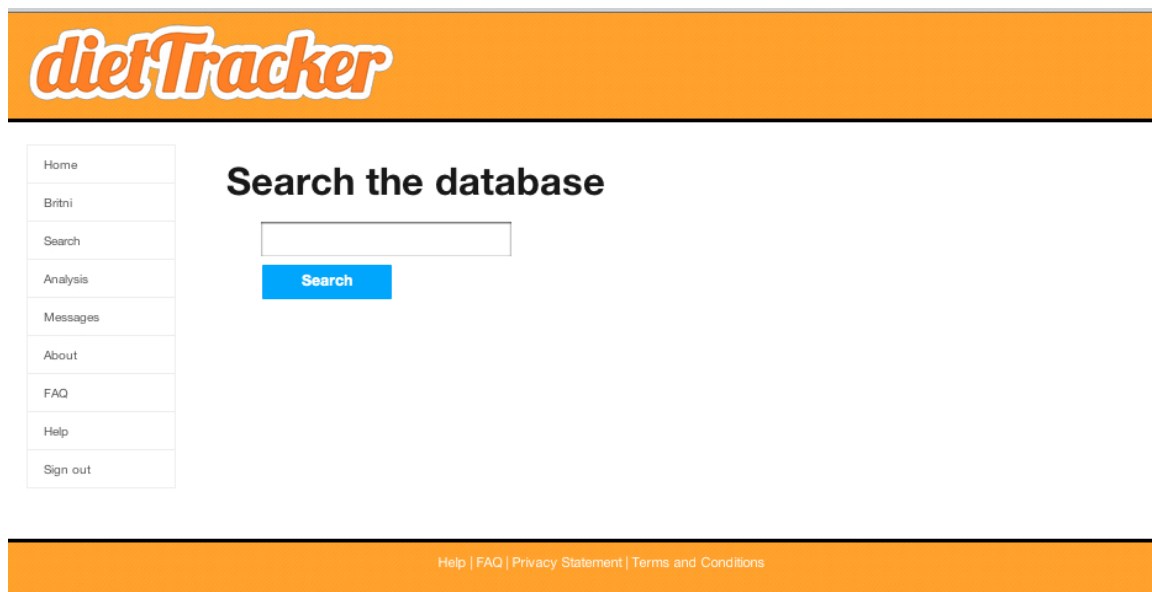
## Analysis

< March 2013 >



*Figure K 6.* Screenshot of the graph participants would view on their analysis page. The graph shows monthly trends in all of the macronutrients shown in the daily summary graph. The graph allowed participants to see trends in their consumption patterns over the course of the month. Participants were also able to hide different macronutrients if they wanted more targeted and personalized information.





*Figure K 7.* Screenshot of the page that participants used when they wanted to search for nutrition information, but not necessarily log it as a meal they had eaten.

**dietTracker**

Home  
Britni  
Search  
Analysis  
Messages  
About  
FAQ  
Help  
Sign out

**Buffalo Chicken Wrap SC\*\* (UMD)** [Search Again | My Foods](#)

**Nutrition Summary**

Daily Value

Nutrient	Daily Value
Calories	1059
Sodium	1110
Fats	96
Sugars	3

Highcharts.com

**Nutrition Facts**

**Calories 1059**      Calories from Fat 608  
Serving size: 1 EACH

Amount/Serving	%DV	Amount/Serving	%DV
<b>Total Fat 68g</b>	<b>104%</b>	<b>Total Carbs 72g</b>	<b>24%</b>
Sat. Fats 17g	86%	Dietary Fiber 9g	35%
<b>Cholesterol 91mg</b>	<b>30%</b>	Sugars 3g	7%
<b>Sodium 1109mg</b>	<b>46%</b>	<b>Protein 41g</b>	<b>81%</b>
<b>Calcium</b>	<b>2%</b>		

The nutrient composition of food may vary due to: genetic, environmental and processing variables; changes in the manufacturer's product formulation; and cooking and preparation techniques.

The information provided should be considered as approximations of the nutritional analysis menu items.

[Help](#) | [FAQ](#) | [Privacy Statement](#) | [Terms and Conditions](#)

*Figure K 8.* Screenshot of the nutrition information for a Buffalo Chicken Wrap eating at the South Campus Dining Hall. This is the type of information that participants would see if they searched for this food in the database, or logged it as one of their tracked meals. The information is displayed in a nutrition label format and also includes a summary graph for the food item.

**dietTracker**

Home
Britni
Search
Analysis
Messages
About
FAQ
Help
Sign out

## About Team DIET

### About Gemstone

Gemstone is a four-year multidisciplinary undergraduate research program at the University of Maryland, College Park, which is sponsored by the University Honors College and the A. James Clark School of Engineering. As participants in this exclusive program, students form research teams in which they develop and execute a long-term project that contributes significant new knowledge in a field of research with the goal of solving societal problems through innovation. Gemstone focuses on research, teamwork, communication, and leadership skills, teaching students to solve problems through cooperation and creativity. The program culminates with a thesis conference in which each team's work is presented to a panel of experts and evaluated. Successful teams have often gone on to publish their work in scholarly journals, seek patents for their designs, or implement their work to improve the community.

Please visit the [Gemstone website](#) for more information.

### About us

Team DIET (Dietary Information and Evaluation Technologies) is a Gemstone team that consists of 12 undergraduate students at the University of Maryland. Our goal is to evaluate how undergraduates' nutritional habits and dietary self-efficacy change when they are granted access to an interactive online nutritional tracking tool that provides meaningful feedback based on their day-to-day choices. Our online tool has been operational since the beginning of the Fall 2011 semester, with a significant redesign in preparation for Spring 2012.

Please visit [our team website](#) for more information.

Feedback & support

*Figure K 9.* Screenshot of the About page on the website. This page allowed participants to find out more information about the Gemstone Program and about Team DIET.

**dietTracker**

Home
Britni
Search
Analysis
Messages
About
FAQ
Help
Sign out

## Frequently Asked Questions

**How do I make a meal?**

To make a meal, go to your [home](#) page and select the **date** you ate the meal. Select the location if you'd like. Then, start typing your food into the **input field**. Once you start typing, a list of possible matches from the database shows up. If there are too many matches, try refining your search (eg. "Chicken Pot Pie" instead of "Pie" or "Chicken") and/or scrolling the list to find the best match for what you ate. Change the number in the serving size box if necessary (this number can be a decimal, such as 0.5). You may also remove items by clicking the x on the top-right corner of the box.

If you would like to add another item, simply press the **plus sign** and follow the steps above. Once you are done adding your meal, press **"Submit"**, and that's it!

**Okay, but what if I forgot something? How do I edit a meal?**

To modify an existing meal, go to your [home](#) page. Your existing meals show up as graphs on the calendar on the day they were eaten. Clicking on the graph will bring you to the [meal show page](#), which shows you an overview of that day's meals. If you would like to **delete** the meal, press **"Delete"**, but remember that once a meal is deleted it cannot be recovered. You can **add** or **remove** foods by editing your meal. Editing the meal is as easy as making one: simply click **"Edit"** and you will be taken to the same form you used to submit the meal. Make any changes you'd like (even change the date) and click **"Submit"**, and presto, you can view your changes!

**Is the data I report confidential?**

The data you report on Team DIET Food Tracker as well as your personal information (such as your email address and your Directory ID) are confidential and will never be used by or released to third parties. Please review our [Privacy Policy](#) for more information.

**How accurate is the nutritional information that I see on the DIET Food Tracker?**

Most of the nutritional information of the foods on our website are taken from the [USDA National Nutrient Database for Standard Reference](#) database set forth by the United States Department of Agriculture. The database was last updated in 2010. We also have information from University of Maryland's Dining Services, please see below for more details. Finally, we also have items from restaurants near campus, and are working hard to add more food.

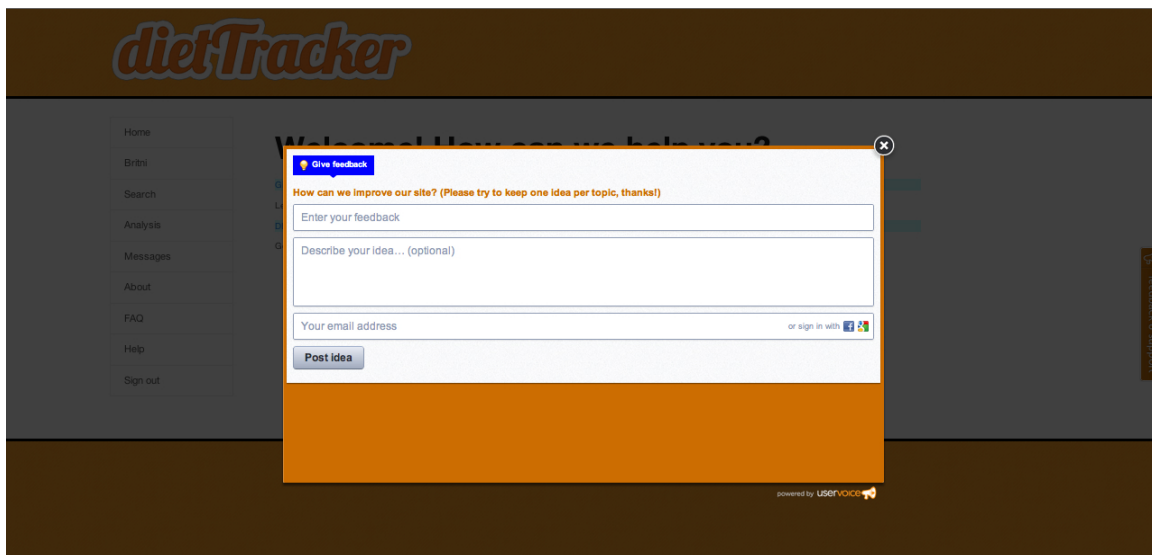
**Where can I get more information on the foods specifically served at the Dining Halls at the University of Maryland?**

These foods are labeled "UMD" in the database. To get more information on the foods served at the University of Maryland's Dining Halls, click [here](#).

**How do I contact the members of Team DIET?**

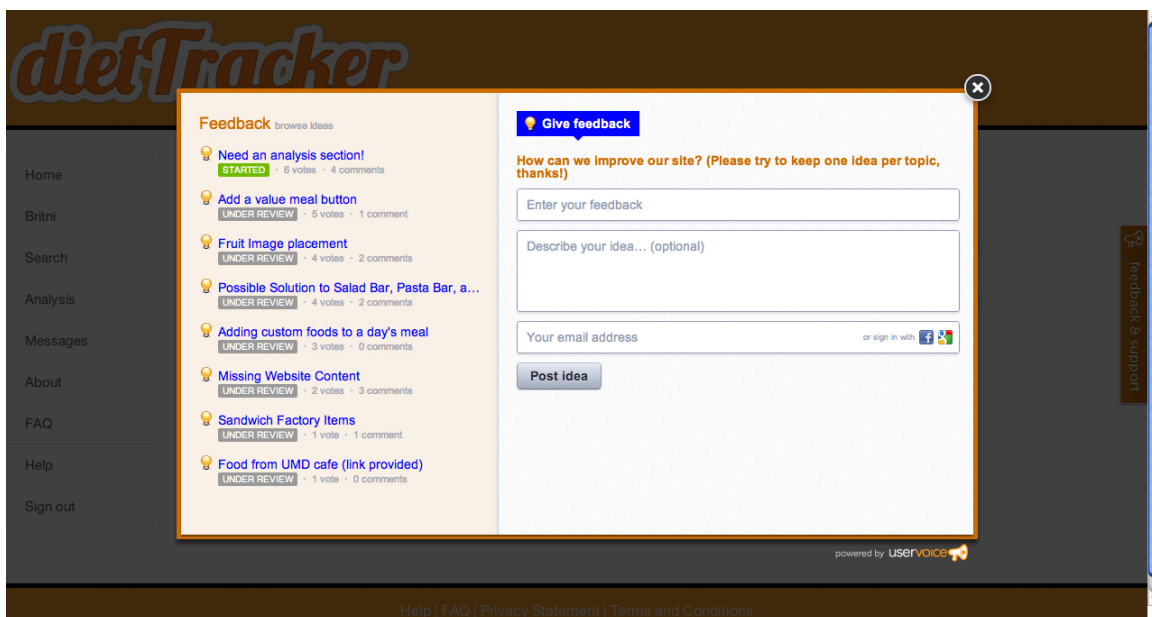
To contact the members of Team DIET email us at [teamdietumd@gmail.com](mailto:teamdietumd@gmail.com).

*Figure K 10.* Screenshot of the Frequently Asked Questions page on the website. This page allowed users to troubleshoot problems they may have been having with the website and helped to answer additional questions that participants commonly asked.



The screenshot shows the dietTracker website with a feedback form overlay. The form is titled "Give feedback" and asks "How can we improve our site? (Please try to keep one idea per topic, thanks!)". It contains three input fields: "Enter your feedback", "Describe your idea... (optional)", and "Your email address". There is a "Post idea" button and a "or sign in with" link with social media icons. The background shows the dietTracker logo and a navigation menu with links like Home, Britni, Search, Analysis, Messages, About, FAQ, Help, and Sign out. A vertical text "powered by UserVoice" is visible on the right side of the form.

*Figure K 11.* Screenshot of the form we used to collect feedback from participants during the duration of the study. This form allowed us to address technical issues quickly and improve the website as participants began using it.



*Figure K 12.* Screenshot of an additional feedback form used during the Spring 2012 study. This page allowed participants to view feedback from others and vote for issues and comments they agreed with. This system gave us a picture of our participants' experience as a whole and allowed us to determine which comments were most important to our participants.



## The Color of Health!

Did you know that eating **fruits and vegetables of different colors** can help you get all the vitamins and minerals you need? Different colored produce, especially **dark green**, **red** and **orange**, include under-consumed (but important!) nutrients<sup>1</sup>. As you're increasing your intake of colored fruits and vegetables, don't forget to keep track!

<sup>1</sup>"Most vegetables and fruits are major contributors of a number of nutrients that are underconsumed in the United States, including folate, magnesium, potassium, dietary fiber, and vitamins A, C, and K" (USDA).

*Figure K 13:* Screenshot of the first nutrition tip sent to participants in Spring 2012. Participants in experimental group two received this message in an email. The message was also uploaded to the website after it had been sent out. Participants in experimental group one were able to see the messages in the website, but did not receive them in an email.



## **Drink milk! Get your daily calcium and vitamin D!**

Dairy products and soymilk are major sources of calcium and vitamin D. It is recommended that you get 800mg of calcium every day. That is the equivalent of 3 to 4 servings of low fat dairy products like skim milk, low fat yogurt, and reduced fat cheese.<sup>1</sup>

<sup>1</sup>Calcium is important for optimal bone health. In addition, "calcium serves vital roles in nerve transmission, constriction and dilation of blood vessels, and muscle contraction." In addition, surprising non-dairy sources of calcium are oranges, spinach, broccoli, and celery. Fruits and vegetables like these can add variety to your calcium intake.

*Figure K 14.* Screenshot of the second nutrition tip sent to participants in Spring 2012. Participants in experimental group two received this message in an email. The message was also uploaded to the website after it had been sent out. Participants in experimental group one were able to see the messages in the website, but did not receive them in an email.





## Get Your Daily Fiber!

Did you know that “moderate evidence shows that adults who eat more whole grains, particularly those higher in dietary fiber, have a lower body weight compared to adults who eat fewer whole grains?”

Whole grain pasta is a great way to incorporate more fiber in your diet. If whole grains aren't your style, incorporate fibrous veggies, like broccoli and artichokes, into your pasta at the South Campus Diner.

<sup>1</sup>Some examples of foods with whole grains are whole-wheat flour, oatmeal, whole cornmeal, and brown rice. Some foods like white bread, white rice, and white flour have been refined, removing much of the dietary fiber.

*Figure K 15.* Screenshot of the third nutrition tip sent to participants in Spring 2012. Participants in experimental group two received this message in an email. The message was also uploaded to the website after it had been sent out. Participants in experimental group one were able to see the messages in the website, but did not receive them in an email.



## **Eat the Good Fats Contained in Vegetables and Seafood!**

Plant foods and seafood have lower amounts of saturated fat than most animal fats. Guacamole, made mostly from avocados, is high in monounsaturated fats, making it a healthier Late Night option than many of the fried foods when consumed in moderation.

According to the USDA, the amount of fat consumed in the diet is not as important as the type of fats consumed. The USDA suggests having roughly a third of one's daily calories to be fatty acids.

*Figure K 16.* Screenshot of the fourth nutrition tip sent to participants in Spring 2012. Participants in experimental group two received this message in an email. The message was also uploaded to the website after it had been sent out. Participants in experimental group one were able to see the messages in the website, but did not receive them in an email.



## **Stay away from added sodium!**

Most dietary sodium comes from salt added during food processing. According to the USDA, "virtually all Americans consume more sodium than they need."

Some ways to reduce sodium include: eating more fresh foods, fewer processed foods, and reading the Nutrition Facts label for information on sodium content and purchase foods low in sodium.

<sup>1</sup>Information according to USDA Dietary Guidelines.

*Figure K 17.* Screenshot of the fifth nutrition tip sent to participants in Spring 2012. Participants in experimental group two received this message in an email. The message was also uploaded to the website after it had been sent out. Participants in experimental group one were able to see the messages in the website, but did not receive them in an email.



## Too Sweet to Eat!

Did you know that added sugars account for 16% of the average American's diet? Many of those are in sodas, energy drinks, deserts, and fruit drinks<sup>1</sup>. Reducing the consumption of these foods with unsweetened drinks and water can help reduce sugar consumption. Don't forget to track!

1. Information according to the USDA.

*Figure K 18:* Screenshot of the sixth nutrition tip sent to participants in Spring 2012. Participants in experimental group two received this message in an email. The message was also uploaded to the website after it had been sent out. Participants in experimental group one were able to see the messages in the website, but did not receive them in an email.

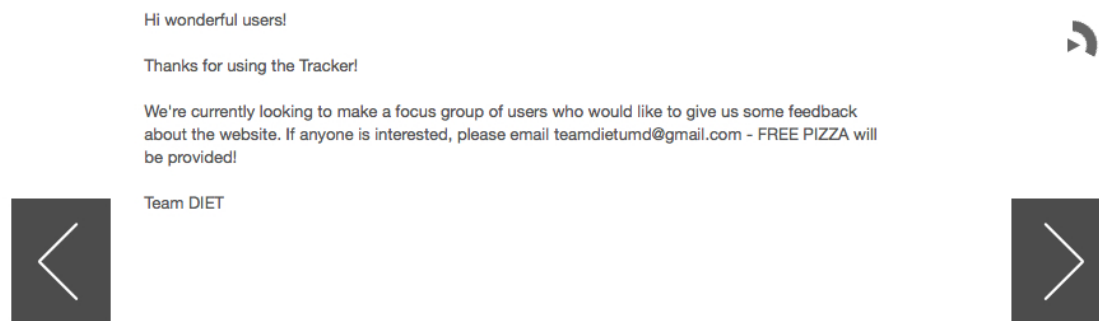


## Balance Your Intake of Protein and Fat!

Having a balanced intake of protein (not too much, not too little!) is an important aspect of healthy eating. The CDC recommends 46 g of proteins daily for women and 52-56 g for men. Good sources of protein include meats, poultry, fish, tofu, beans and peas, eggs, milk products and others. Even some vegetables, such as asparagus, cauliflower, broccoli, artichokes, are high in protein. To make lower-fat protein choices in your diet, remove the skin from turkey or chicken. Go vegetarian and substitute black or pinto beans for meat in tacos, or substitute tofu for beef in stir fry. You can also switch to low-fat or fat-free milk, yogurt and cheese.

*Figure K 19.* Screenshot of the seventh nutrition tip sent to participants in Spring 2012. Participants in experimental group two received this message in an email. The message was also uploaded to the website after it had been sent out. Participants in experimental group one were able to see the messages in the website, but did not receive them in an email.

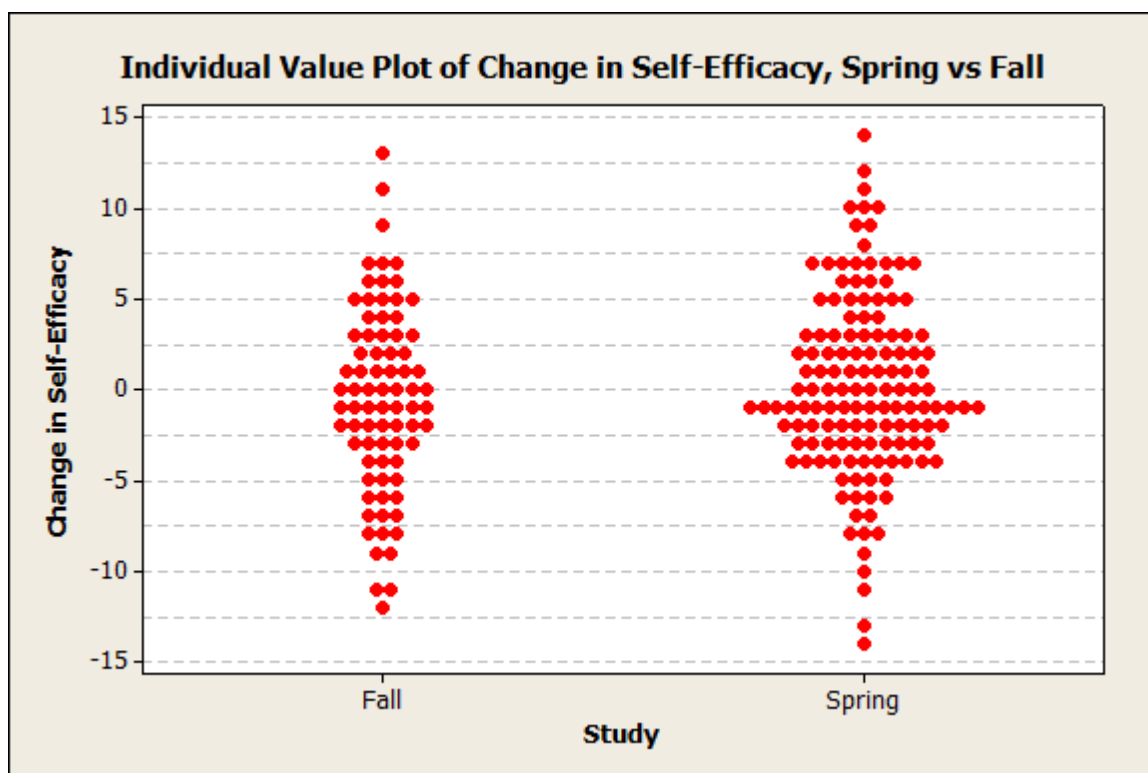
## Messages



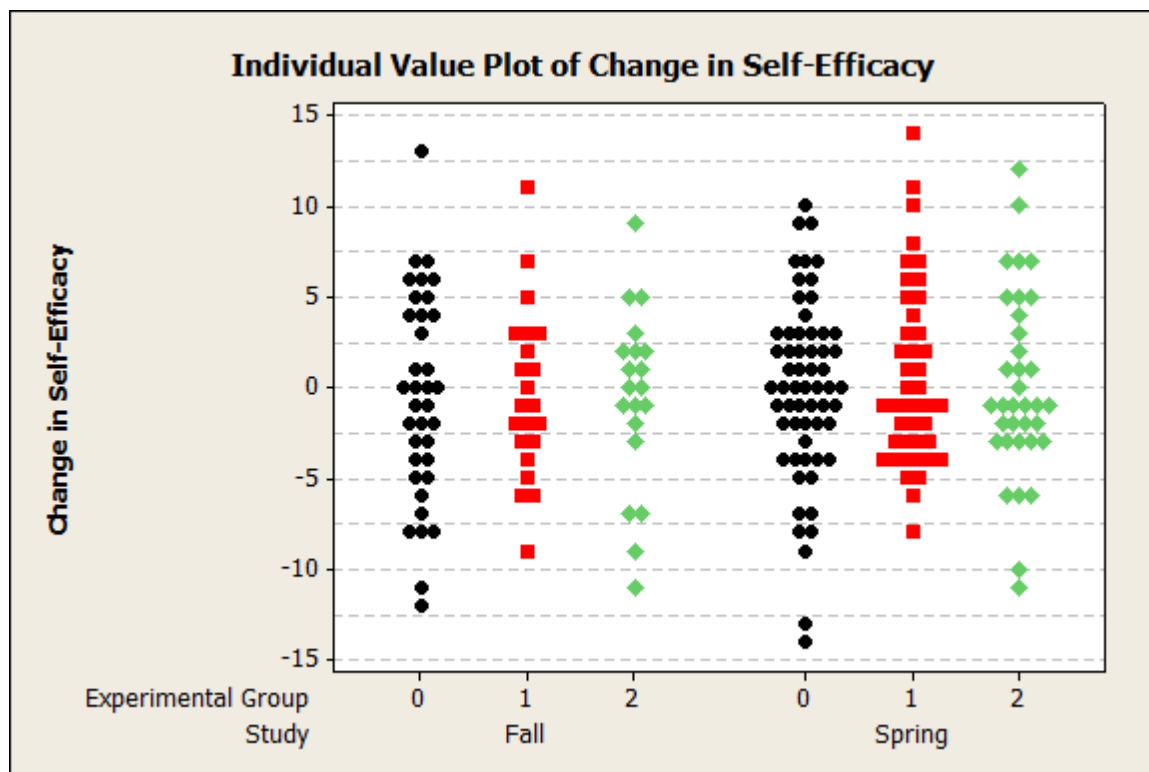
*Figure K 20:* Screenshot of an announcement sent out through the website in Spring 2013. The message advertised additional research for the study in an attempt to collect more qualitative data about the DIET Tracker.

## Appendix L

## Data Charts from Results

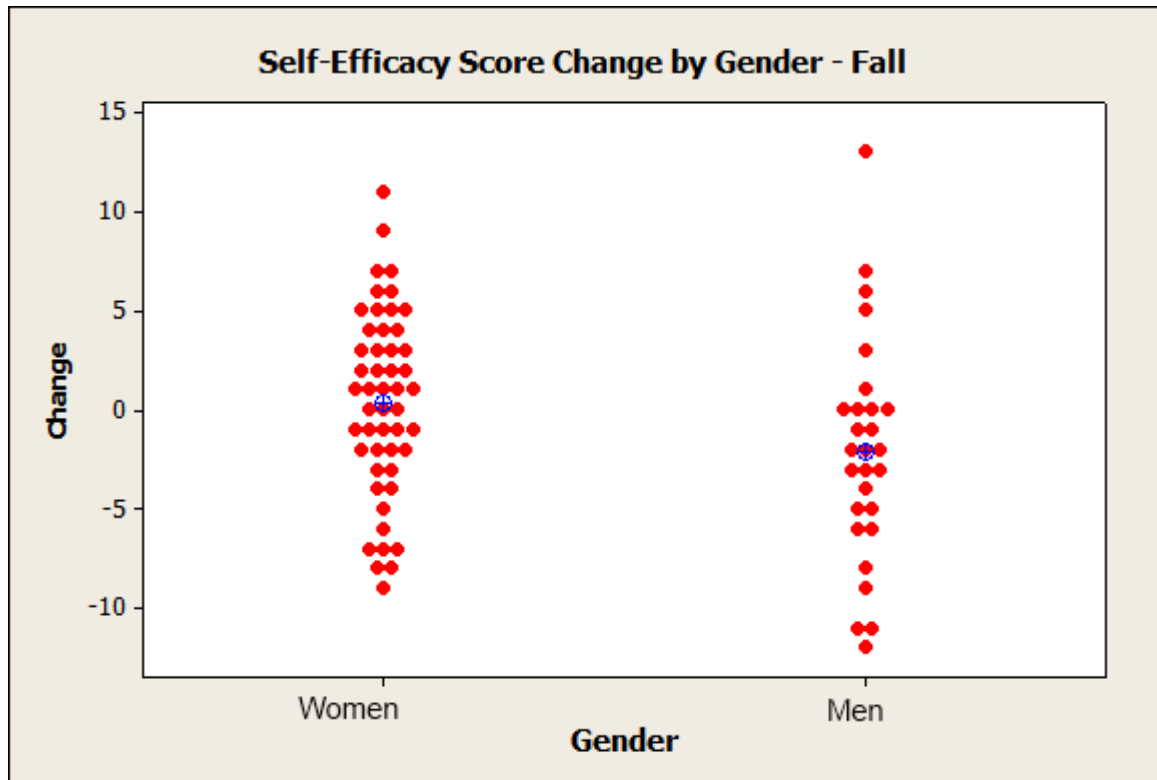


*Figure L 1.* Individual value plot of the change in self-efficacy score for all participants in the Fall 2011 and Spring 2012 studies, separated by gender. Most participants' self-efficacy remained fairly constant, with the bulk of changes less than 5 points in either direction.

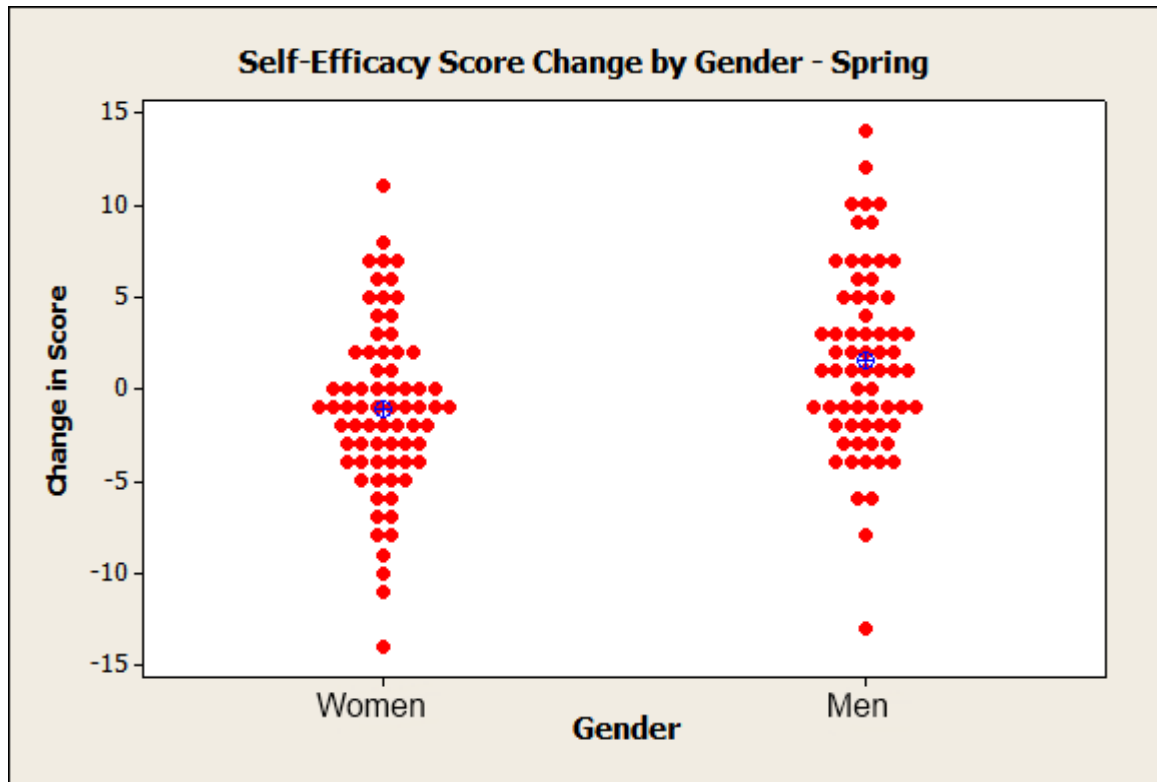


*Figure L 2.* Individual value plot of the change in self-efficacy score for all participants in the Fall 2011 and Spring 2012 studies, separated by experimental group. For each study, 0 represents the control group (black circle), 1 represents experimental group 1 (red square), and 2 represents experimental group 2 (green diamond) for each study. There was similar overall distribution among different groups in both studies.

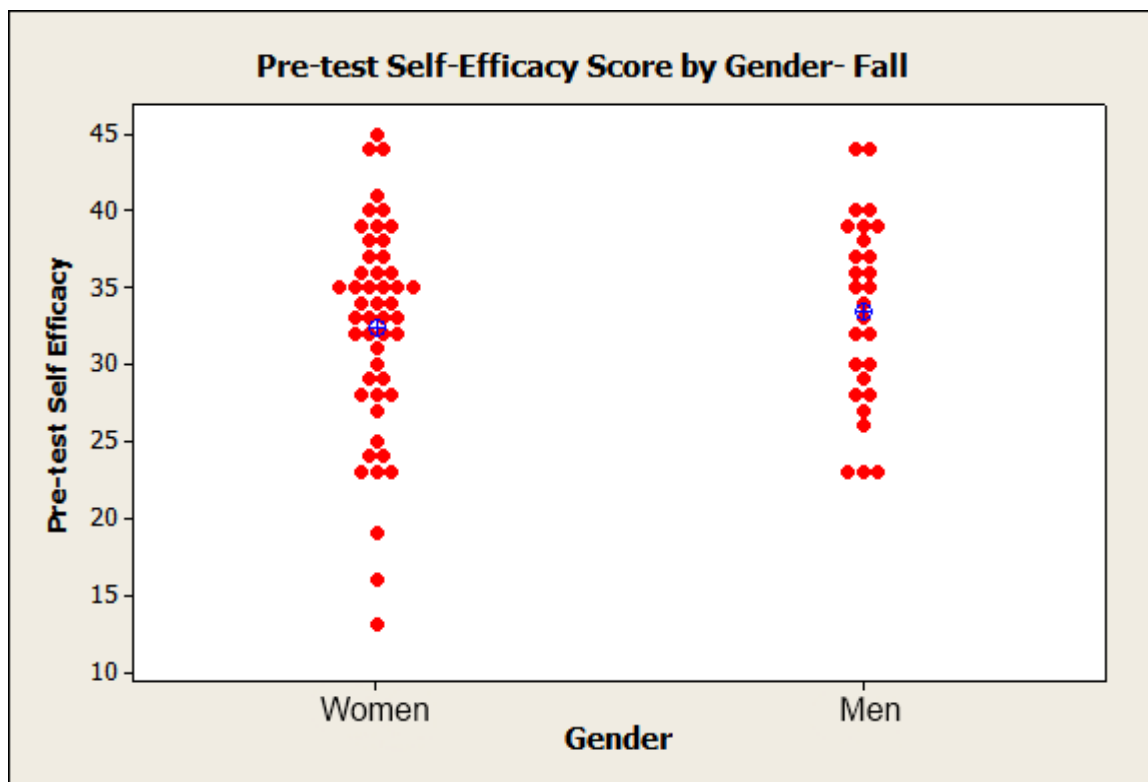




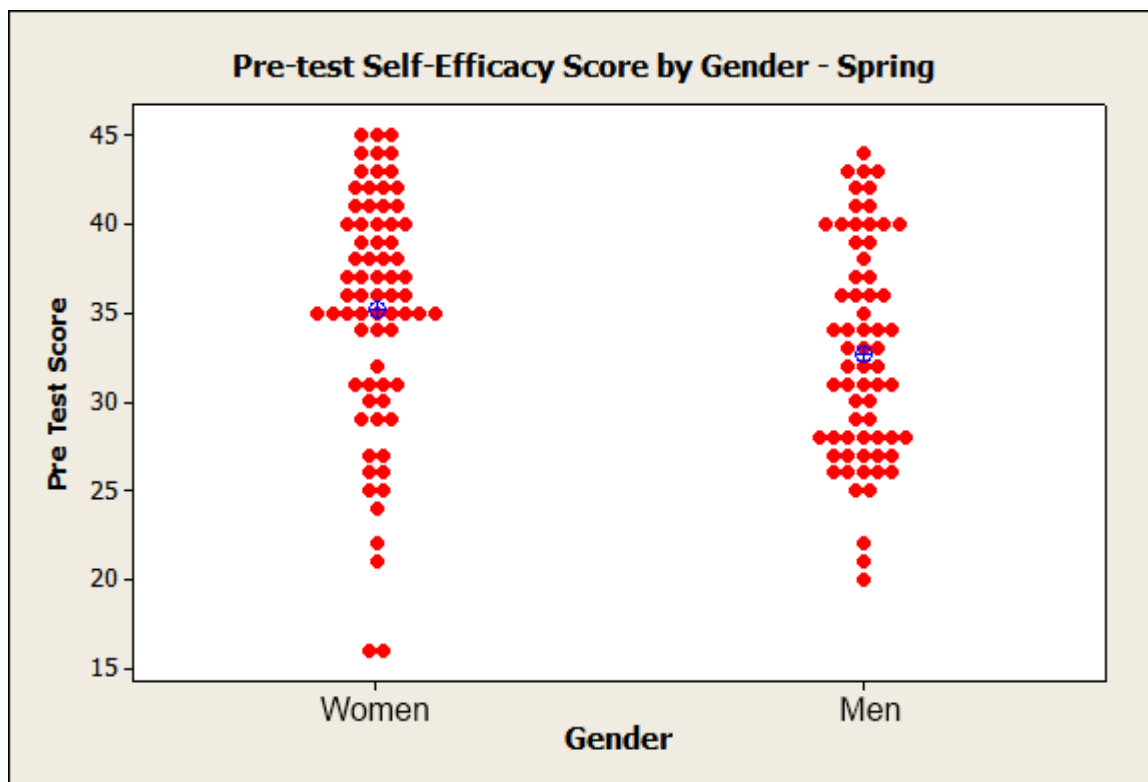
*Figure L 3.* Individual value plot of the change in self-efficacy score for all participants in the Fall 2011 study, separated by gender. Men showed less consistency in score, shown by their larger range. They also had overall lower scores, with a clustering in the bottom (negative) half of the plot, unlike women, who clustered evenly in both halves of the plot.



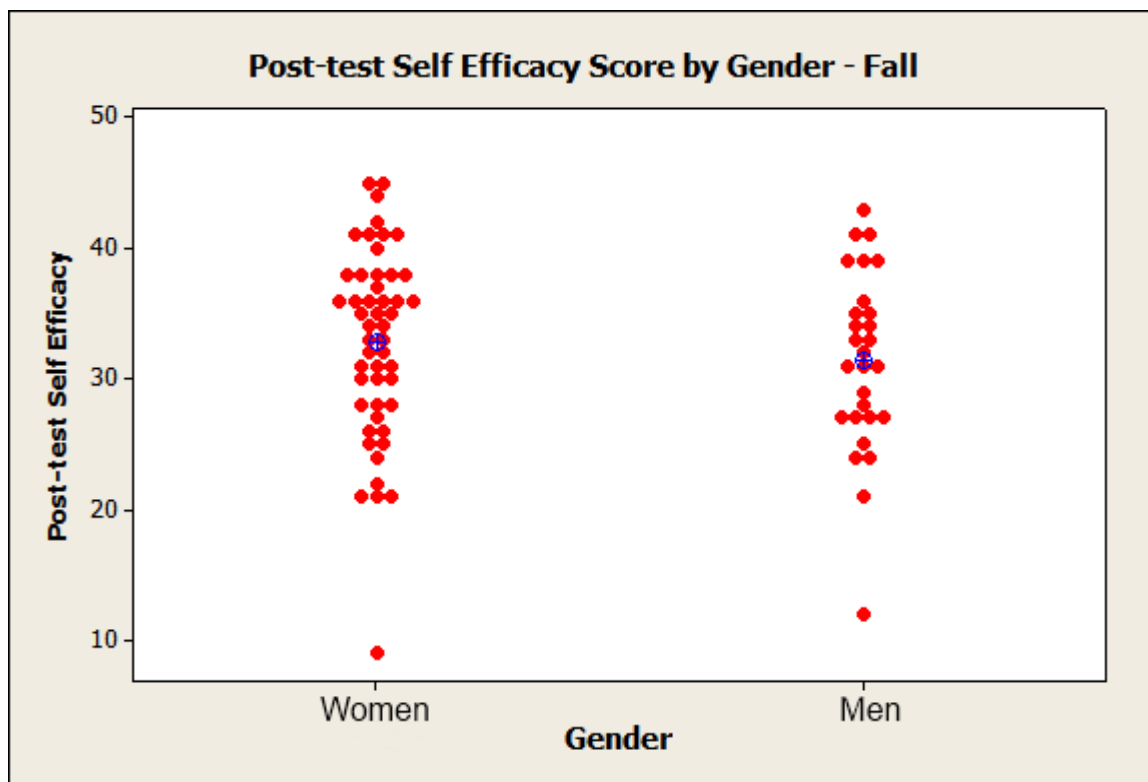
*Figure L 4.* Individual value plot of the change in self-efficacy score for all participants in the Spring 2012 study, separated by gender. Women had overall lower scores, with a clustering in the bottom (negative) half of the plot, unlike men, who clustered evenly in both halves of the plot, with slightly higher density in the top (positive) half.



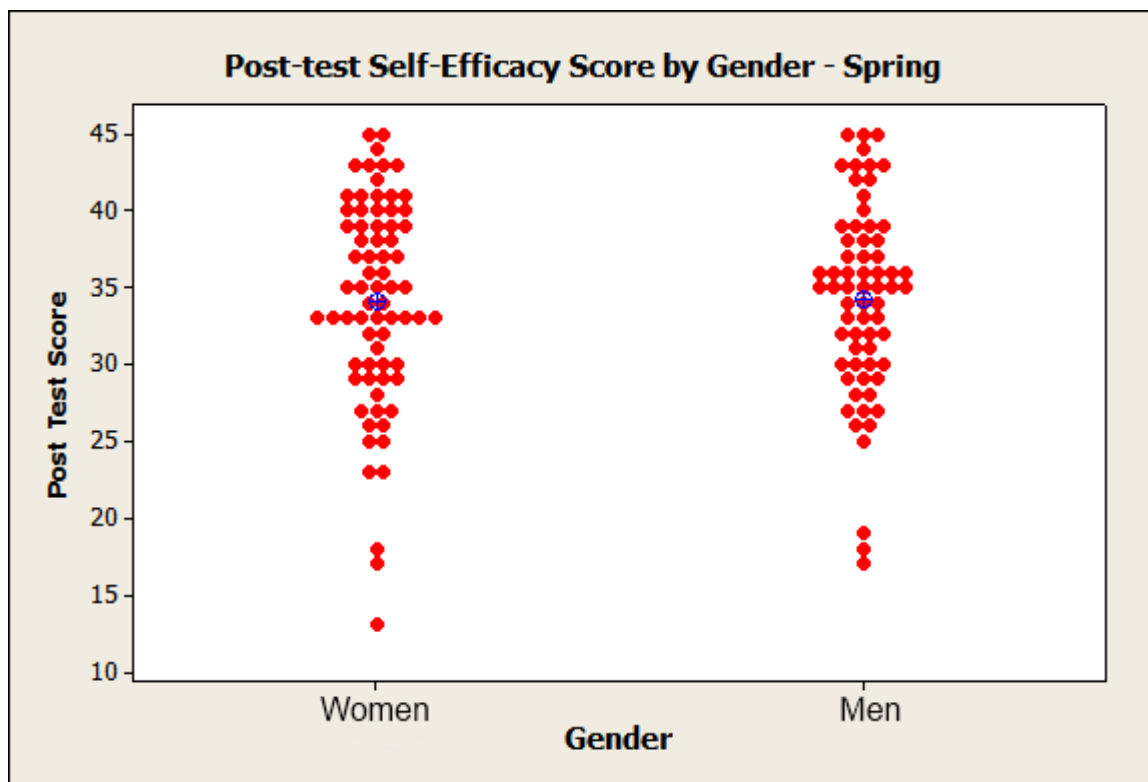
*Figure L 5.* Individual value plot of the pre-test self-efficacy score for all participants in the Fall 2011 study, separated by gender. Both genders had similar distributions and clustered between 30 and 40 points, a score indicating participants had “confident” fruit and vegetable self-efficacies. This graph shows that there were little major differences between men and women in the beginning of the Fall 2011 study.



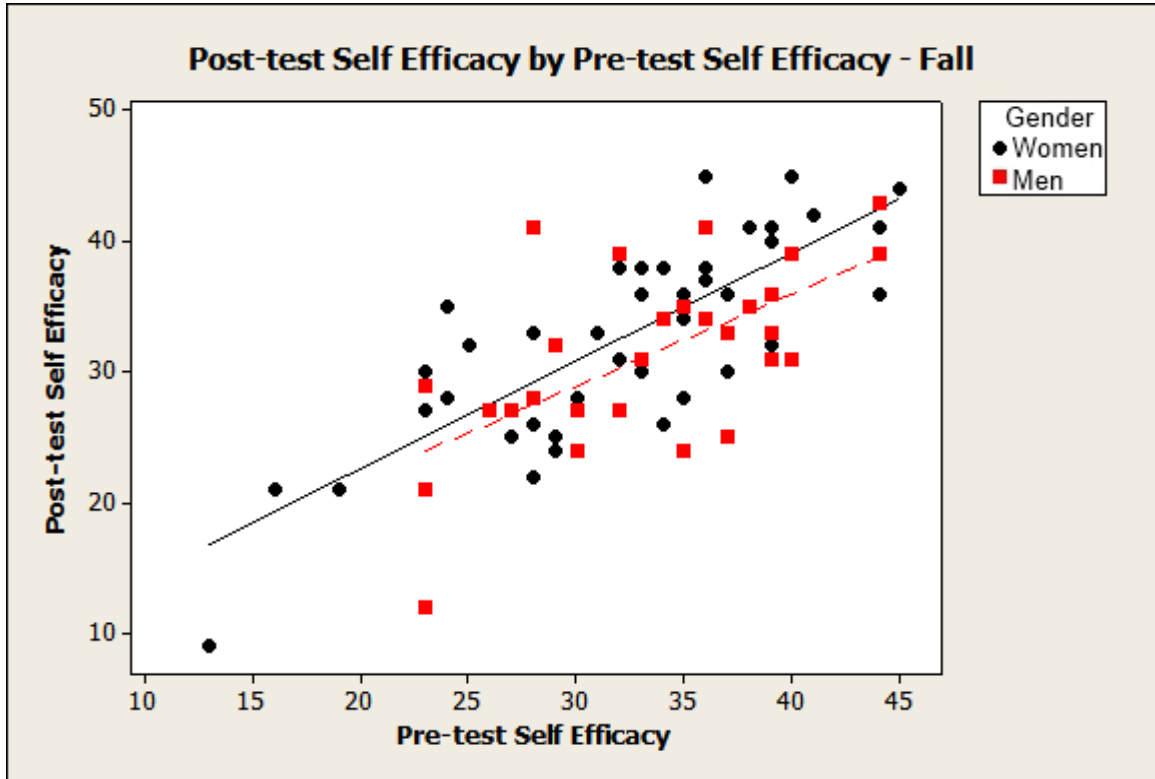
*Figure L 6.* Individual value plot of the pre-test self-efficacy score for all participants in the Spring 2012 study, separated by gender. Women’s scores clustered between scores of 35 and 45, showing “confident” and “very confident” fruit and vegetable consumption self-efficacies. Men’s scores were less consistent but lower in general, with a minor cluster between the scores of 25 and 30, denoting “neither confident nor not confident” self-efficacy. This graph shows that there were major differences between men and women in the beginning of the Spring 2012 study.



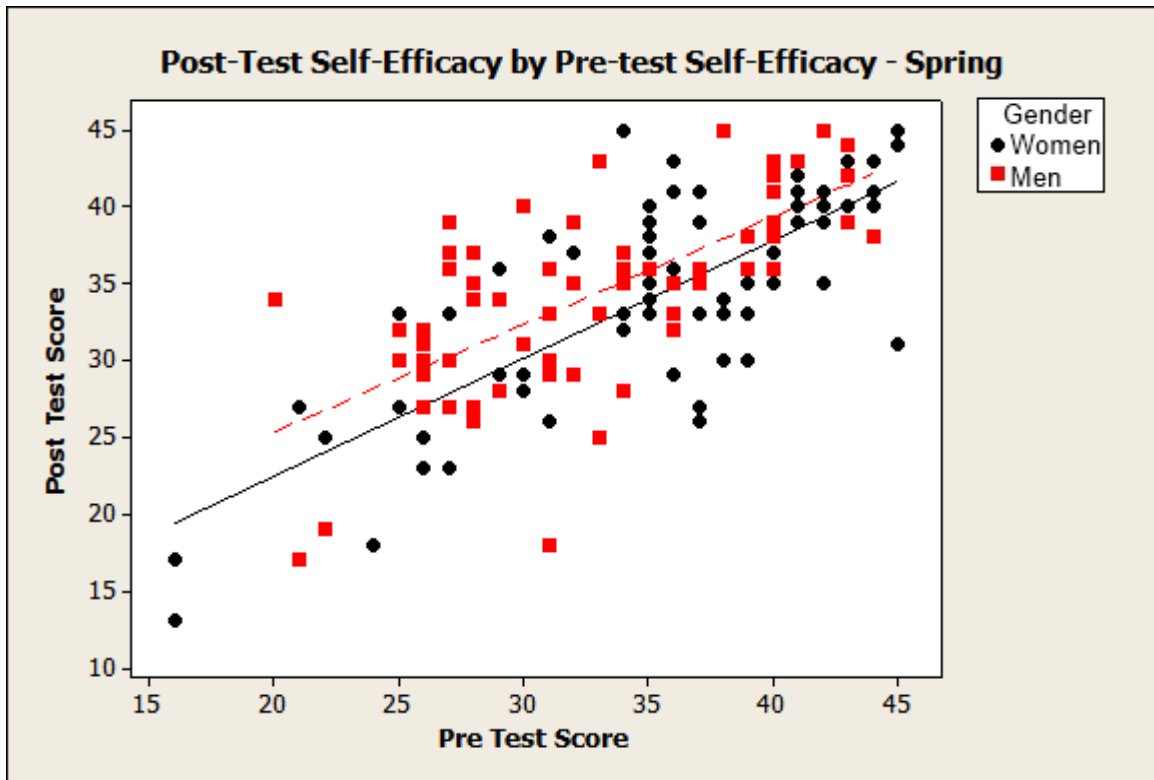
*Figure L 7.* Individual value plot of the post-test self-efficacy score for all participants in the Fall 2011 study, separated by gender. Both genders had similar distributions and clustered between 30 and 40 points, a score indicating participants had “confident” fruit and vegetable self-efficacies. This graph shows that there were little major differences between men and women at the end of the Fall 2011 study.



*Figure L 8.* Individual value plot of the post-test self-efficacy score for all participants in the Spring 2012 study, separated by gender. Both genders had similar distributions and clustered between 30 and 40 points, a score indicating participants had “confident” fruit and vegetable self-efficacies. This graph shows that there were little major differences between men and women by the end of the Spring 2012 study.

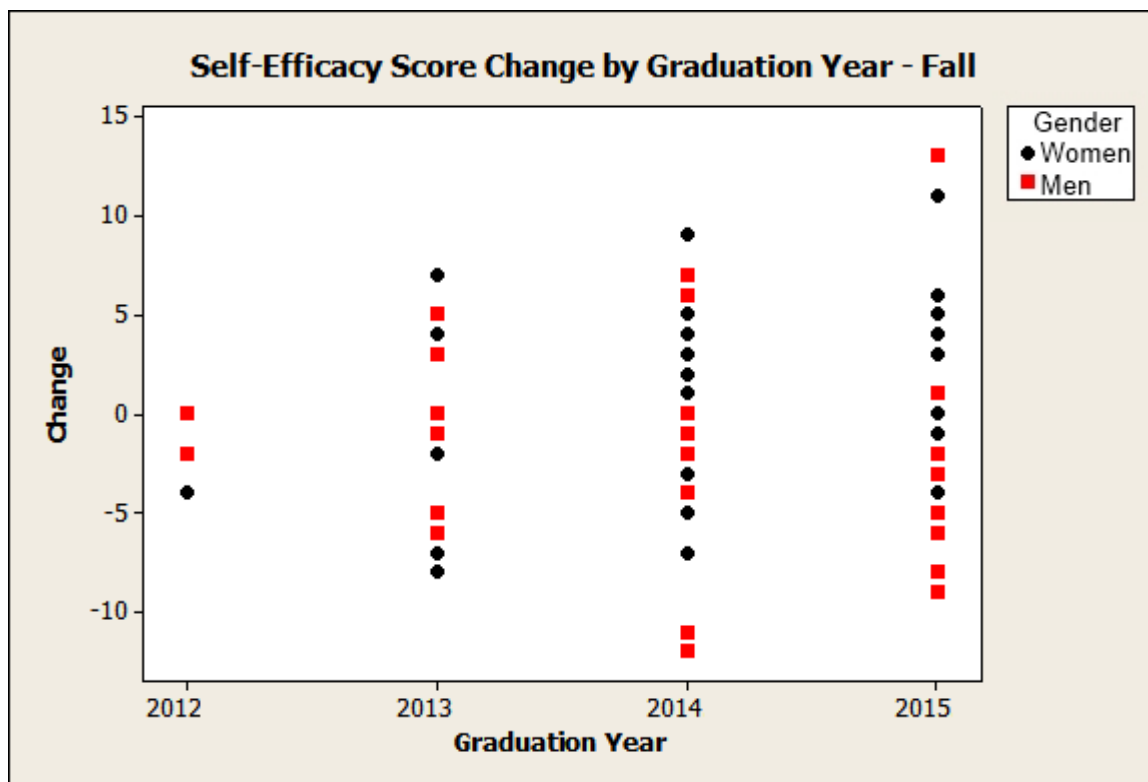


*Figure L 9.* Scatterplot of pre-test self-efficacy scores compared to post-test self-efficacy scores for participants in the Fall 2011 study, separated by gender. The black solid line is the least-squares regression line of best fit for women (black circles), and the red dotted line is the least-squares regression line of best fit for men. The distribution of pre- and post-test scores are similar between men and women, as shown by both lines being similar in location and slope, though women's scores were higher on average than men's scores, as shown by their higher best fit line. Both lines show a strong correlation between men and women's pre- and post-test self-efficacy, showing that participants' self-efficacy did not on average change much, and that pre-test self-efficacy score was a good predictor of post-test self-efficacy scores.

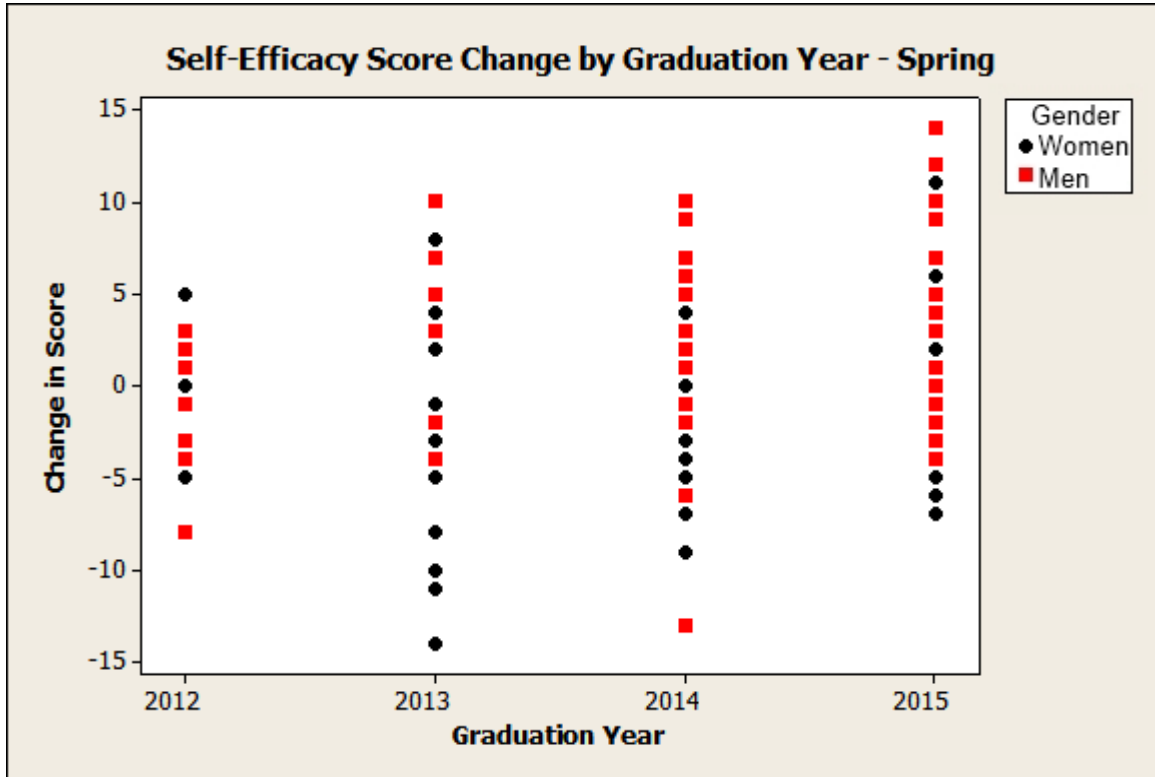


*Figure L 10.* Scatterplot of pre-test self-efficacy scores compared to post-test self-efficacy scores for participants in the Spring 2012 study, separated by gender. The black solid line is the least-squares regression line of best fit for women (black circles), and the red dotted line is the least-squares regression line of best fit for men. The distribution of pre- and post-test scores are similar between men and women, as shown by both lines being similar in location and slope, though men's scores were higher on average than women's scores, as shown by their higher best fit line. Both show a strong correlation between pre- and post-test self-efficacy, showing that participants' self-efficacy did not on average change much, and that pre-test self-efficacy score was a good predictor of post-test self-efficacy scores.

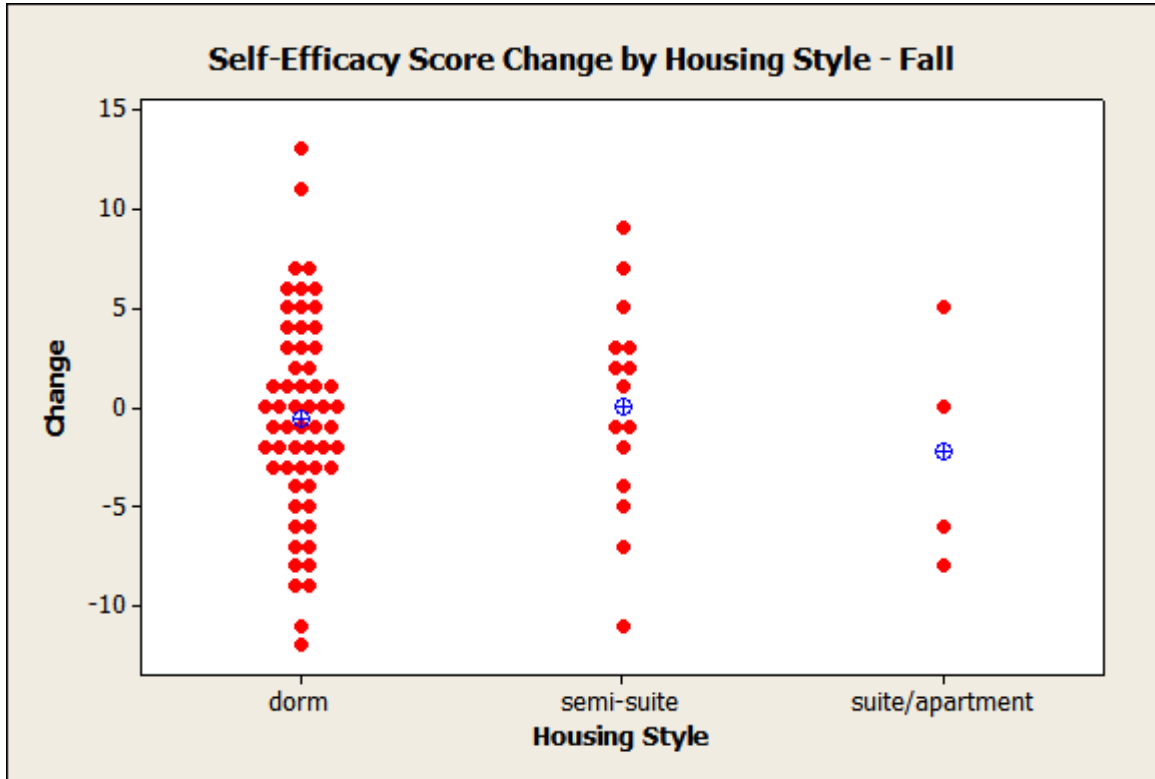




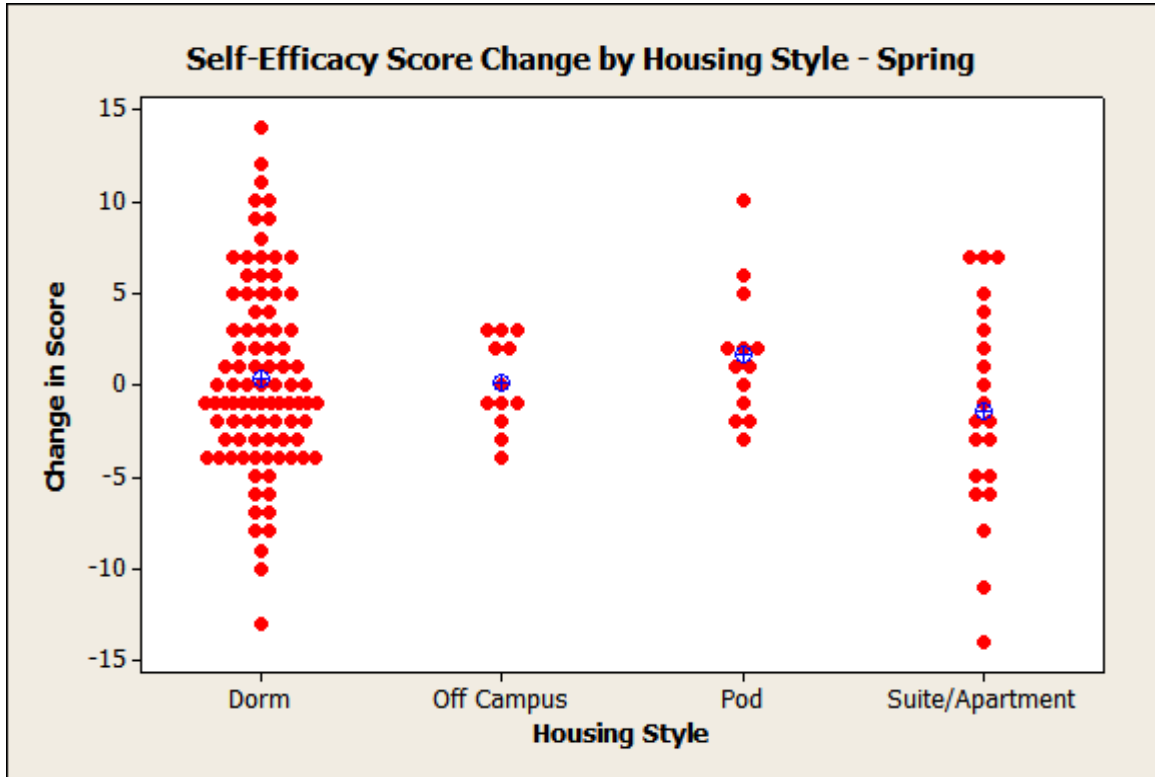
*Figure L 11.* Individual value plot of the change in self-efficacy score for all participants in the Fall 2011 study, separated by graduation year and labeled by men (red square) and women (black circles). This graph shows very little correlation between graduation year and change in self-efficacy scores, as the values for each graduation year are fairly equally distributed around the center of the plot, which denotes no change.



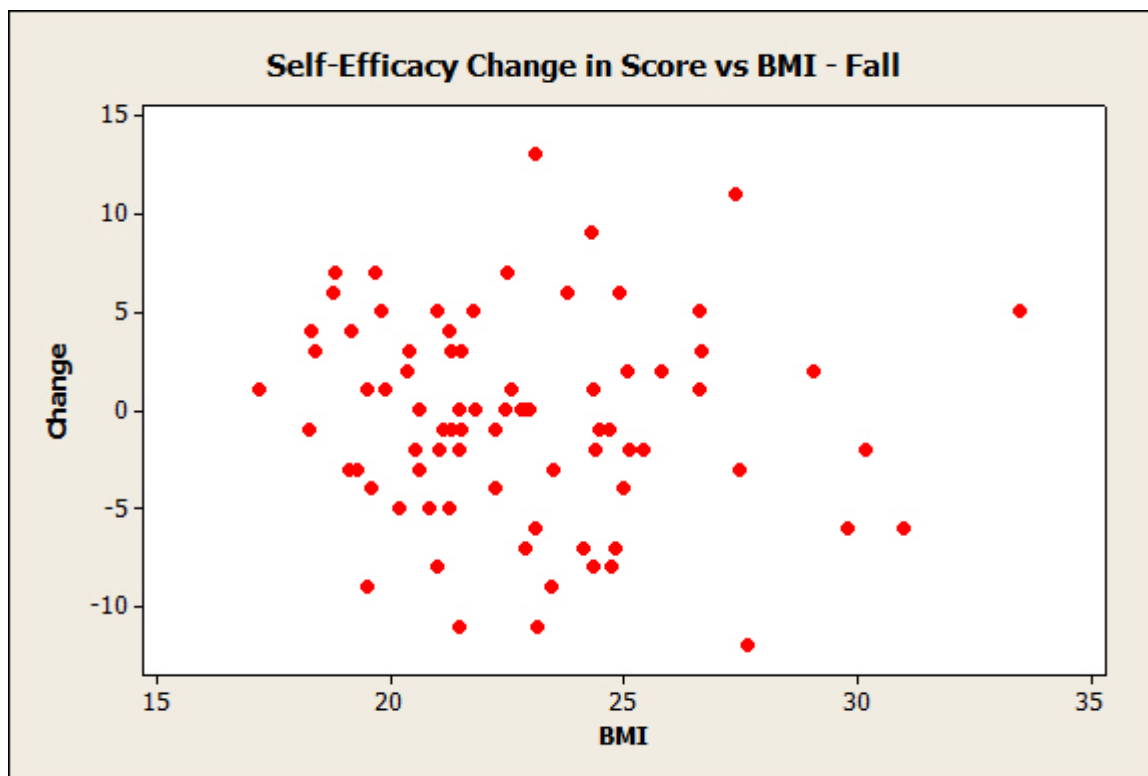
*Figure L 12.* Individual value plot of the change in self-efficacy score for all participants in the Spring 2012 study, separated by graduation year and labeled by men (red square) and women (black circles). This graph shows very little correlation between graduation year and change in self-efficacy scores, as the values for each graduation year are fairly equally distributed around the center of the plot, which denotes no change, though the class of 2015 had a slightly more positive change than the rest.



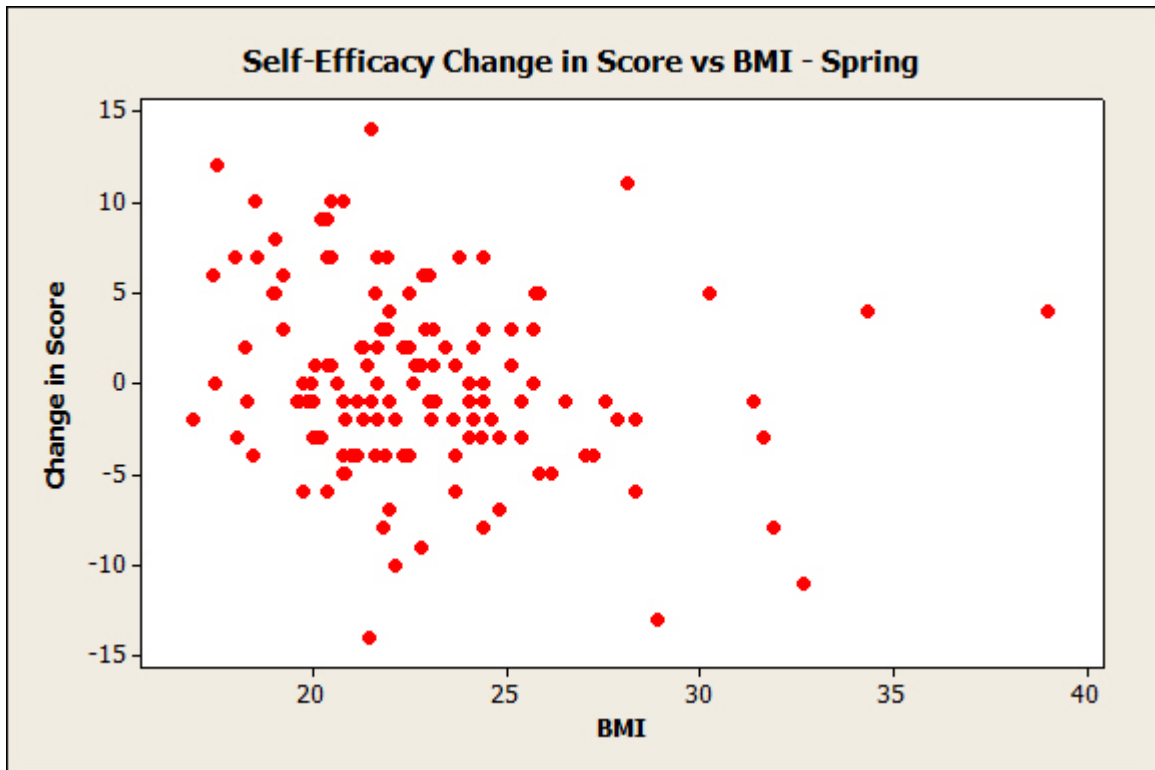
*Figure L 13.* Individual value plot of the change in self-efficacy score for all participants in the Fall 2011 study, separated by housing style. This graph shows very little correlation between housing style and change in self-efficacy scores, as the values for each category are fairly equally distributed around the center of the plot, which denotes no change. It also shows that the majority of participants lived in dorm housing.



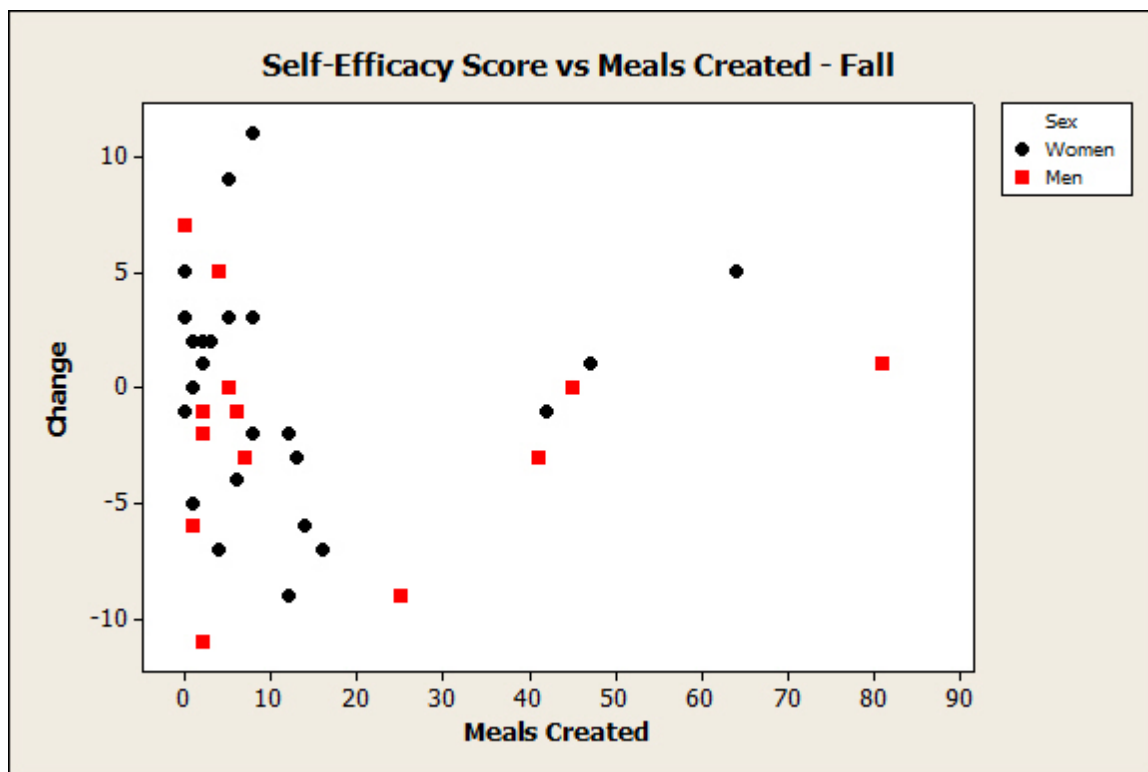
*Figure L 14.* Individual value plot of the change in self-efficacy score for all participants in the Fall 2011 study, separated by housing style. This graph shows very little correlation between housing style and change in self-efficacy scores, as the values for each category are fairly equally distributed around the center of the plot, which denotes no change. It also shows that the majority of participants lived in dorm housing.



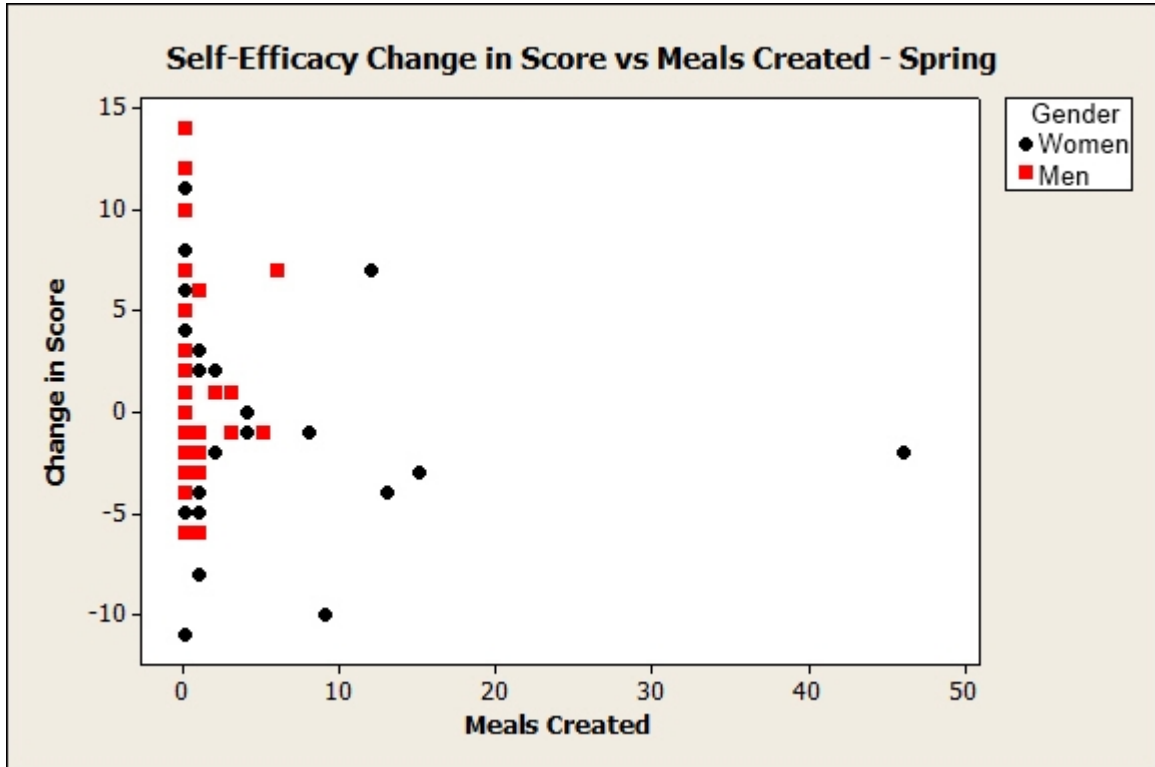
*Figure L 15.* Scatterplot of change in self-efficacy scores compared to the Body Mass Index (BMI) of participants in the Fall 2011 study. This plot shows no correlation between BMI and self-efficacy score among participants in this study.



*Figure L 16.* Scatterplot of change in self-efficacy scores compared to the Body Mass Index (BMI) of participants in the Spring 2012 study. This plot shows no correlation between BMI and self-efficacy score among participants in this study.

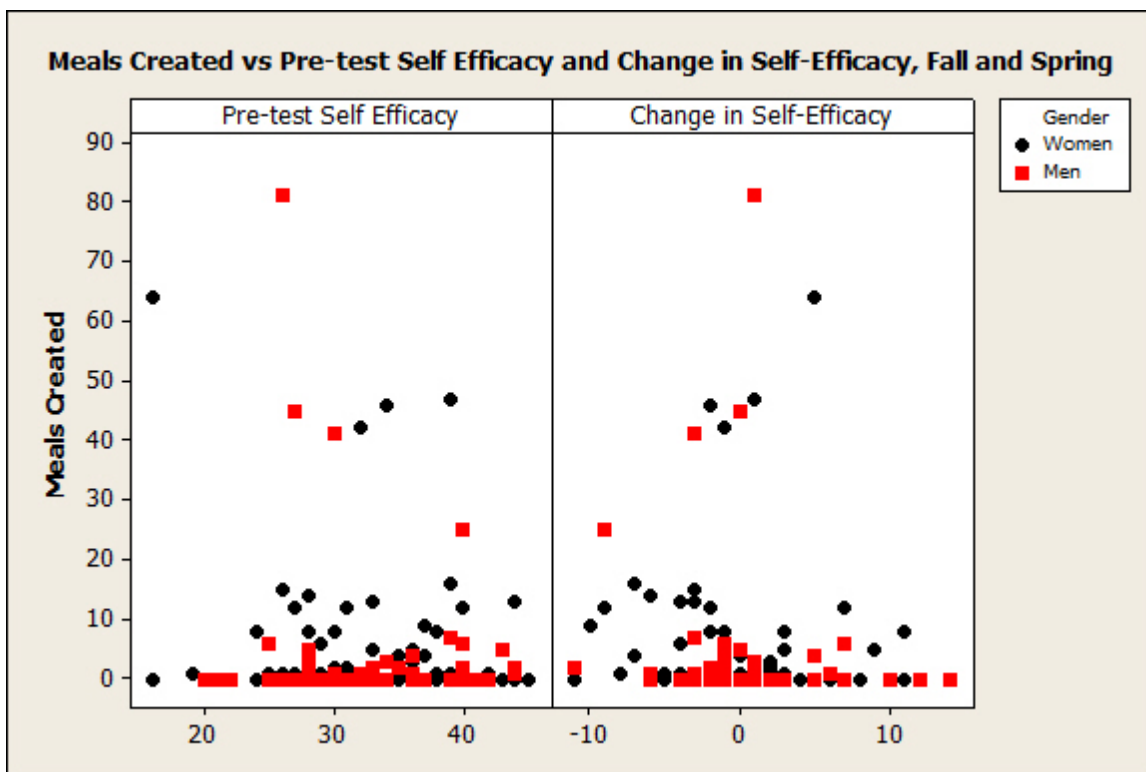


*Figure L 17.* Scatterplot of change in self-efficacy scores compared to the meals created by participants in the Fall 2011 study. Please note that a data point, denoting a participant who created 168 meals, was removed as an outlier. This plot shows very little correlation between the number of meals created by users and the change in users' self-efficacy. It also shows little correlation between the number of meals created by men (red squares) and women (black circles). Finally, it also shows the relatively low number of meals created by our participants, with most participants creating less than ten meals.

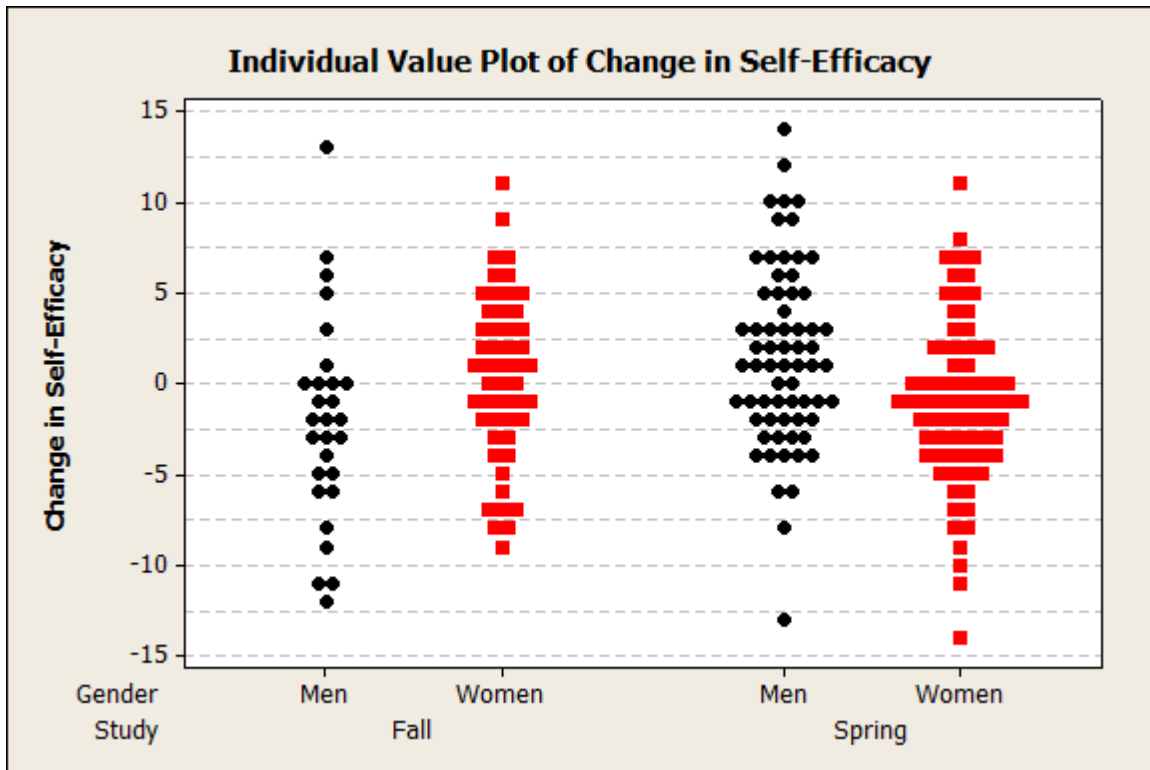


*Figure L 18.* Scatterplot of change in self-efficacy scores compared to the meals created by participants in the Spring 2012 study. This plot shows very little correlation between the number of meals created by users and the change in users' self-efficacy. It also shows the women (black circles) made more meals than men (red squares). Finally, it also shows the relatively low number of meals created by our participants, with most participants creating less than five meals.





*Figure L 19.* Scatterplot comparing meals created with pre-test self-efficacy score and change in self-efficacy score in both Fall 2011 and Spring 2012, distinguishing between men (red squares) and women (black circles). Please note that a data point, denoting a participant who created 168 meals, was removed as an outlier. This plot shows little correlation between meals created and self-efficacy score (both pre-test score, change in score and by extension, post-test score).



*Figure L 20.* Individual value plot of the change in self-efficacy score for all participants in both the Fall 2011 and Spring 2012 studies, separated by gender. This graph illustrates the difference between the changes in self-efficacy among men (black circles) and women (red squares) in both studies. In the Fall 2011 study, women had higher self-efficacy than men in general, as shown by the left half of the plot. In the Spring 2012 study, men had higher self-efficacy than women in general, as shown by the right half of the plot.

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