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THE EFFECT OF NUTRIGENOMICS EDUCATION ON THE DIETARY HABITS OF COLLEGE STUDENTS

By

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ABSTRACT

Nutrigenomics is a newly researched area that investigates the interplay between nutrition and genetics. Theoretically, this information could enable registered dietitians to provide personalized, tailored nutrition recommendations unique to a given individual and enable individuals to alleviate future health concerns, such as cancer and heart disease. Given the potential importance of such research, the current study investigated the behavioral response of college students to this information. Seventy-five students from a small, Midwestern liberal arts university were recruited to participate in survey research. Utilizing a true experiment design, control and experimental groups completed a pretest survey measuring current dietary habits and their likeliness to change their habits when provided with nutrigenomics information, with the experimental group first having to attend an informational session on nutrition, nutrigenomics, and genetics. Approximately five months after the administration of the first survey, participants completed an online posttest survey designed to determine whether or not the students' dietary habits had changed. Statistical analyses found no significant differences between any survey responses, including both pre- and posttest survey data. Therefore, in the current study, nutrigenomics education did not result in a behavioral change. While the results do confirm those of other researchers, the question still begs to be asked why such important and potentially life-saving information does not cause individuals to change their dietary habits.

Keywords: Nutrigenomics, nutrigenetics, dietary habits, behavior change, college students.

INTRODUCTION

Nutrigenomics is a newly researched area of study that makes personalized nutritional care and treatment based on an individual's specific genes possible. Much research has been conducted in the past two decades in this area, with numerous correlations between specific genes and nutrients being identified. Additionally, many genes are believed to be linked to certain chronic disease states, with dietary modification given as a possible treatment option. Even more important, these dietary interventions, if taken in early adulthood, are able to decrease an individual's future risk/development of conditions such as type II diabetes and cancer.

With that in mind, the question begs to be asked whether or not knowledge of this type of information and the ability to address and/or alleviate future health conditions before they occur would cause an individual to change their current lifestyle, and specifically, dietary habits in order to decrease their risk of disease. Specifically, this study sought to discover whether college students, given the importance of their lifestyle and health choices on their lives in the future, would be willing to change their current dietary habits when presented with nutrigenomics research. Furthermore, would this information result in college students actually changing their eating habits?

REVIEW OF LITERATURE

Dietary habits of college students

It has long been said that young people are the key to the future. Recently, it has been discovered that young people are even the key to their own future, at least in regards to their future health status. While the title health encompasses a wide area, the area of an individual's nutritional status has become increasingly scrutinized and investigated due to the prevalence of chronic health conditions directly related to nutrition, such as obesity, type II diabetes, and cardiovascular disease, in 21st century society. A study by Brown, Geiselman, and Broussard (2010) demonstrated the importance of healthful dietary habits in early adulthood. In their research on female African American college students, they found that 87% of study participants consumed more than the daily recommended amount of dietary fat, with 18% of all study participants having a family history of coronary heart disease (pp. 1190; 1188). This information is important because "increases in lesion thickness through processes additional to lipid accumulation begin relatively early in life" (Stary, 2000, p. 1178). In other words, the dietary habits of these students placed them at an even greater risk for early development of atherosclerosis, a beginning component of cardiovascular disease.

DeBate, Topping, and Sargent (2001) conducted research to investigate the dietary practices of college students, finding that only 64% of participants were at a healthy weight as indicated by Healthy People 2010 guidelines, with the percentages for African American students, when analyzed separately, being even lower (pp. 823, 829). They also found that, out of the 707 college students surveyed, only 31.2% consumed the recommended amount of fruit, 1.3% consumed the recommended amount of vegetables, and 6.9% consumed the recommended amount of bread, cereal, rice, and pasta, as given by the Food Guide Pyramid (p. 825). These dietary recommendations are in place in order to promote optimum health in an

individual; when not followed, an increased risk and/or development of chronic disease can and often does occur. Current data regarding the dietary habits of college students reveals similar information. A survey of 105,781 undergraduate college students found that 58.3% consumed 1-2 servings of fruits and vegetables per day, 30.1% consumed 3-4 servings per day, with only 6.2% consuming 5 or more servings per day (American College Health Association, 2011). Another issue surrounding college students' dietary habits and their future health risks, in addition to inadequate nutrient consumption and the high prevalence of overweight/obesity is the fact that students who are not overweight do not see the need for "healthy dietary practices" because they believe that this "correspond[s] solely to weight" (Rasberry, Chaney, Housman, Misra, & Miller, 2007, p. 81). This research regarding the use of nutrition labels by college students indicates the need for nutrition education for college students regarding reasons for healthful eating (besides weight loss) and also for "food selections" that meet their individual nutritional needs (p. 81).

An introduction to nutrigenomics

The need for nutrition education and counseling in college students being evident, a new area of research has been discovered that holds enormous potential for addressing and providing individualized nutrition information. Nutrigenomics is an up and coming area of study that provides personalized nutritional care and treatment based on an individual's specific genes. DeBusk, Fogarty, Ordovas, and Kornman (2005) state that "nutritional genomics will fill a critical gap in developing evidence-based nutritional interventions" (p. 594). As defined by Bouwman (2009), "nutrigenomics studies the relationship of what we eat and how our genes, proteins, and metabolism function to affect our long term health" (p. 100). In other words, this area, often referred to as nutrigenomics, looks at how an individual's genetics determine how nutrients are used by their body. Addressing an individual's nutrition by their genetic makeup is

important for three primary reasons. According to Fenech et al. (2011), these factors include the genetic variability among people which in turn affects how nutrients are utilized, the difference of "food/nutrient availability and choices" between individuals, and the effect that malnutrition can have on "gene expression and genome stability" (p. 70). Furthermore, Fenech et al. state that "it is not only naïve, but also likely dangerous, to assume all individuals will respond identically to the foods they consume" (p. 85).

Nutrients affect an individual's phenotype (how an individual's genes are expressed) by making more proteins available for a given desirable process, providing a substitute for missing biochemicals resulting from "limitations in our genetic material", and also by deactivating genes whose expressions are harmful to the body's role (DeBusk, 2003, p. 5). Much research has been done in the past two decades in this area, with numerous correlations between specific genes and nutrients being identified. Additionally, many genes are believed to be linked to certain chronic disease states, with dietary modification given as a possible treatment option. Nutrigenomics information "is about to bring tailor-made nutrition (or personalized nutrition) into practice" (Kato, 2008, p. 12). Stated more confidently, "discoveries made in the field of nutrigenomics should translate into more effective dietary strategies to improve overall health by identifying unique targets for prevention" (Fenech et al., 2011, p. 74). Even more important, these dietary interventions, if taken in early adulthood, are able to decrease an individual's future risk and/or development of conditions such as type II diabetes and cancer.

Nutrigenomics, nutrigenetics, and nutritional genomics

While the terms nutrigenomics, nutrigenetics, and nutritional genomics sound very similar, they do vary in meaning. Nutrigenetics looks at how an individual's genetic makeup affects how nutrients are utilized by the body, whereas nutrigenomics is concerned with how nutrients can effect and even change the genome. Finally, then, nutritional genomics "is

concerned with determining the nutritional components that are most compatible with health," and is therefore a term that encompasses nutrigenetics and nutrigenomics (DeBusk, Fogarty, Ordovas, & Kornman, 2005, p. 590). An example of nutrigenomics would be a B vitamin deficiency, which would "impair DNA synthesis/stability and increase DNA mutation rates (germ line and somatic DNA mutations)" (Stover & Caudill, 2008, p. 1481). Nutrigenetics, on the other hand, can be demonstrated by the example of the VDR gene. "Certain variants of this gene apparently cause the vitamin D receptor – the molecular "landing pad" that receives this vitamin's chemical message – to be slightly altered in shape" (DeBusk & Joffe, 2006, p. 87). This change affects the metabolism of vitamin D and also the functioning of calcium and phosphate.

Nutrigenomics research

HDL Cholesterol

One well-known example of nutrigenomics at work is in the APOA1 gene, which is involved in high density lipoprotein (HDL) cholesterol levels. HDL is commonly referred to as the "good" cholesterol, picking up and transporting cholesterol throughout the body, which assists in preventing atherosclerosis. Often, a diet high in polyunsaturated fats is recommended for individuals needing to raise their HDL cholesterol levels. This typical protocol works adequately for those with the APOA1 gene. However, in those with the APOA1 gene variation of APOGs1, the exact same diet high in polyunsaturated fats actually results in their HDL levels becoming lower, which is the opposite of what is desired for the patient (DeBusk & Joffe, 2006). Additional research suggests that the APOE gene may also contribute to this phenomenon. This gene has four different forms, the fourth of which, (E4), has been shown to cause a greater responsiveness to LDL and total cholesterol levels than the other variants of this gene (Lovegrove & Gitau, 2008). "People with this variant... tend to have higher total cholesterol levels...and are also particularly susceptible to the harmful effects" of smoking and diabetes risk

(if they are overweight) (DeBusk & Joffe, 2006, p. 28). This example demonstrates how an individual's genes may, and many times do, have the power to determine how a nutrient is utilized by the body.

Cancer

Another area where the gene-nutrition interaction has been under study is in cancer research. Martin (2007), in a research article on the topic of using nutrigenomics to investigate apoptosis in cancer, stated that "aberrantly regulated apoptotic cell death is a hallmark in the pathogenesis of cancer" (p. 438). Apoptosis is a term that simply indicates a type of cell death. This process is important in cancer because, unless the cancer-causing cells are themselves destroyed, they will continue to grow and replicate, in addition to killing other "good" cells, resulting in the spread of the cancer. Therefore, the apoptosis of the cancerous cells is a desired process and one has been found possible to be influenced by nutrigenomics (p. 438). A specific example given by Martin is that "inadequate dietary selenium is linked to increased apoptosis" (p. 440). Because of this and the anti-cancer properties selenium (Se) appears to possess, "....Se-deficient individuals may benefit from Se-supplements that allow optimal expression of the Se-enzymes; and apparently Se-adequate individuals may further benefit from metabolizing greater amounts of Se" (Combs, 1999, p. 19). The entire reason that this scenario occurs is because of the polymorphism glutathione peroxidase (Gpx) and thioredoxin reductase (TR), which "may play roles in inhibiting by free radical-initiated DNA damage," demonstrating once again the importance of the nutrient-gene interaction (Combs, 1999, p. 19). Furthermore, it has been demonstrated that dietary fiber may serve an important role in the prevention of colorectal cancer. It seems that butyrate, which is dietary fiber fermented by the intestinal bacteria, leads to the apoptosis of tumors and thus inhibits tumor growth (Fenech et al., 2011, p. 81).

Functional foods

Functional foods is a category used to describe foods believed to provide a health benefit above and beyond that provided by the nutrients present in the food. Some foods that would fall into this category include green tea and oily fish. Green tea provides many antioxidants, which are believed to provide protection against cancer. In a review article by Ferguson (2009), it was found that "the gene-diet associations identified to date have suggested that green tea may be protective against carcinogenic agents and that certain variations in genes associated with metabolism and/or detoxification can reduce the efficacy of a green tea intervention" (p. 456). A study by Yuan, Koh, Sun, Lee, & Yu (2005), found that Chinese women with a high-activity angiotensin I-converting enzyme (ACE) genotype variant saw a reduced breast cancer risk with green tea intake, whereas women with a low-activity ACE genotype saw no effect in their risk of breast cancer development with green tea consumption. Additionally, no anti-cancer properties were found with consumption of black tea. Therefore, the "functionality" of functional foods may be dependent upon an individual's genotype as well as the exact type of food consumed.

Obesity

In the midst of our societal health crisis of obesity, it is no wonder that researchers are attempting to determine possibilities for this condition. After compiling research from different studies, Fenech et al. (2011) determined that "the presence of the FTO variant may connote susceptibility to obesity in an environment where food (particularly foods of high energy density) is readily available and low physical activity is common" (p. 77). This thought is supported in a review article by Day and Loos (2011), which states that "since the discovery of FTO many studies have examined whether its effect on BMI and obesity risk is attenuated by a physically active lifestyle or a healthy diet" (p. 232). Although perhaps not what the public wants

to hear, the studies reported in this review did indeed find that the FTO gene variant may be susceptible to the effects of a healthy diet and active lifestyle, meaning that these activities can reverse an individual's genetic susceptibility to obesity.

Vitamin D

Vitamin D is currently under much discussion given that many Americans do not consume adequate amounts of this vitamin, which is especially important for bone health. A review article by Davis and Milner (2011) cited studies that "serve as proof-of-principle that genetic polymorphisms can modify the relationship between vitamin D status and cancer risk" (p. 4). Genetic variations are also thought to alter the overall effect of the body to vitamin D.

Taste perception

Finally, recent research has shown there to be a correlation between taste perception and an individual's genes. Duffy and Bartoshuk (2000) conducted a study in which they investigated whether or not individuals who were able to taste 6-*n*-propylthiouracil (PROP) as very bitter could taste sugars as sweeter, bitter substances as more bitter, and fats ingested as creamier than those who taste PROP as less bitter. They found that women who found the taste of PROP to be more bitter also had a lesser liking for "sweet and high-fat food and beverage groups" (p. 647). It is interesting to ponder whether or not these findings may be related to the current obesity epidemic in the United States. Perhaps taste is a factor because individuals tend to primarily consume foods that they find palatable. If palatability is related to genes, may one then say that obesity is also semi-related to an individual's genetics? It is questions like these that keep the study of nutrigenomics new, exciting, and relevant to 21st century healthcare.

Implications of nutrigenomics

With the vast amount of genomic information now available, along with the large number of nutrient-gene interactions understood, the era of personalized, individualized

healthcare is soon to become a reality as well as an everyday part of the medical arts. Armed with a patient's genetic profile, clinicians, dietitians included, will be able to tailor treatment plans directly to the needs of the patient, allowing for more beneficial and effective healthcare. "Anticipated outcomes are improved treatment and prevention of chronic diseases and, ultimately, the ability to maximize one's genetic potential" (DeBusk, Fogarty, Ordovas, & Kornman, 2005, p. 590). Not only that, but genomics also holds possible potential for preventative healthcare. For example, individuals will be able to know, based on their individual genetic makeup, if they are at an increased risk for a chronic disease state based on their own genetics; their risk will no longer be determined simply because by their family history or other disease risk factors. When paired with nutrigenomics, this will potentially allow an individual to address future health concerns and the development of chronic disease states before they occur.

With that in mind, a logical question to ask is whether or not knowledge of this type of information and the ability to address and/or alleviate future health conditions before they occur would cause an individual to change their current lifestyle, and specifically, dietary habits in order to decrease their risk of disease. Specifically, this study sought to discover whether college students, given the importance of their lifestyle and health choices on their lives in the future, would be willing to change their current dietary habits when presented with nutrigenomics research. Furthermore, if educated on these topics, would this information result in college students actually changing their eating habits?

METHODS

Upon receiving approval from the Institution Review Board, a pilot study of 28 students from a small, Midwestern, liberal arts university was conducted in order to provide a basis for further research. For the current study, student research participants were recruited from chemistry, psychology, sociology, nutrition, genetics, and communications courses at the same university. Following a true experiment research method and utilizing a between groups design, the 75 recruited students were divided into control and experimental groups. Random assignment to conditions resulted in 38 students being assigned to a control group, in which they received no further treatment or information. This group completed a survey, consisting of questions that investigated whether or not they would be willing to make changes in their diet if they knew that this could address future health conditions, which were answered on a Likert-type scale of 1 to 7 (in lieu of yes/no or multiple choice questions). Remaining survey questions included the students' gender, academic status (freshman, sophomore, etc.), major, familiarity with their family medical history, and current dietary habits. (See Appendix A for copy of survey). The remaining 37 participants made up the experimental group. This group attended an informational session, in which basic information regarding nutrition, genetics, nutrigenomics, and diet-disease relationships was presented; all participants received a handout that included important information presented. Following this session, participants in this information-receiving "experimental" group completed the same survey given to the control group. (See Appendix B for copy of education session handout).

Additionally, both groups completed an online post-survey, conducted through Survey Monkey©, approximately five months after completing the initial survey. Fifty-three participants completed this post-survey, 27 from the control group and 26 from the experimental group. This measure consisted of the same dietary questions as were included on

the initial survey, so as to determine whether or not the student's dietary habits had changed as a result of information received. The control group was included in this post-survey as an additional control measure.

RESULTS

An independent samples *t*-test between control and experimental group pre-survey data discovered there to be no significant differences seen in any survey questions between the two groups (see Table 1). The control group rated their familiarity with their current family medical history as 5.444 (on a 1-7 Likert-style scale) and their past family medical history as 4.972. The experimental group rated their current familial medical history knowledge as 5.472, rating the past family medical history as 5.056. Both groups showed a similar likeliness to change their dietary habits based on nutrigenomics research, the control group as 5.667 and the experimental group as 5.500. Finally, both groups rated their likeliness to change their dietary habits if they possessed an increased risk for disease in a similar manner, 6.250 for the control group and 6.389 for the experimental group. None of these results proved to be statistically significant. In other words, both control and experimental groups possessed the same familiarity with their current and past family medical history, the same likeliness to change their dietary habits based on nutrigenomics research, and also the same likeliness to change their dietary habits if they hypothetically possessed an elevated risk for heart disease, cancer, or stroke.

A factorial analysis of variance between the pre- and posttest survey responses from within both the experimental and control groups was completed to see whether or not dietary habits changed in the post-survey. This analysis found no significant differences between pre- and post-survey responses (See Table 2). No significant changes were present in the consumption of fruit, vegetables, meat, "junk" foods, dairy products, grains, and processed foods between the control and experimental groups, nor were differences found in dietary habits between the experimental and control groups.

Table 1

Mean Pretest Responses

Survey Question	**Control Group n = 38**	**Experimental Group n = 37**
Familiarity with current family medical history	5.444	5.472
Familiarity with past family medical history	4.972	5.056
Likeliness to change dietary habits based on nutrigenomics research	5.667	5.500
Likeliness to change dietary habits given elevated risk for disease	6.250	6.389

Note. Responses rated on 1-7 Likert-style scale.

A factorial analysis of variance between the pre- and posttest survey responses from within both the experimental and control groups was completed to see whether or not dietary habits changed in the post-survey. This analysis found no significant differences between pre- and post-survey responses (See Table 2). No significant changes were present in the consumption of fruit, vegetables, meat, "junk" foods, dairy products, grains, and processed foods between the control and experimental groups, nor were differences found in dietary habits between the experimental and control groups.

Table 2

Mean Food Consumption by Number of Times Eaten Per Day

Food Group	Type of Test	Control Group	Experimental Group
Fruit	Pretest	2.250	2.000
	Posttest	2.077	1.808
Vegetable	Pretest	2.250	1.806
	Posttest	1.963	1.423
Meat	Pretest	1.944	2.257
	Posttest	1.778	2.154
"Junk" Foods	Pretest	2.556	2.444
	Posttest	2.037	2.192
Dairy	Pretest	2.528	3.000
	Posttest	2.037	2.577
Grains	Pretest	3.778	3.343
	Posttest	3.154	3.308
Processed Foods	Pretest	1.111	1.083
	Posttest	1.000	0.885
	Posttest	1.000	0.885

Finally, an additional factorial analysis of variance found no significant differences between the dietary habits of control and experimental groups when separated by sex (see Table 3). However, marginally significant statistical differences were found between control and experimental groups for female vegetable consumption and also between control and experimental groups for male dairy consumption. Even though statistically significant, these minimal differences are not of practical importance when analyzing an individual's dietary habits.

Table 3

Mean Food Consumption By Number of Times Eaten Per Day Sorted By Gender

Food Group	Type of Test	Gender	Control Group	Experimental Group
Fruit	Pretest	Male	2.455	2.400
		Female	2.160	1.846
	Posttest	Male	2.333	2.600
		Female	2.000	1.619
Vegetable	Pretest	Male	2.364	1.900
		Female	2.200*	1.769*
	Posttest	Male	2.167	1.200
		Female	1.905*	1.476*
Meat	Pretest	Male	2.273	3.000
		Female	1.800	1.960
	Posttest	Male	2.000	2.800
		Female	1.714	2.000
"Junk" Foods	Pretest	Male	2.909	2.000
		Female	2.400	2.615
	Posttest	Male	2.333	2.000
		Female	1.952	2.238
Dairy	Pretest	Male	2.545*	3.900*
		Female	2.520	2.654
	Posttest	Male	2.167*	3.000*
		Female	2.000	2.476
Grains	Pretest	Male	4.364	3.600
		Female	3.520	3.240
	Posttest	Male	3.000	3.400
		Female	3.200	3.286
Processed Foods	Pretest	Male	1.364	1.300
		Female	1.000	1.000
	Posttest	Male	0.833	1.400
		Female	1.048	0.762

*Statistically significant

DISCUSSION

Although limited, some studies have investigated whether or not genetics information would result in a behavioral change, whether that be related to diet or general health (i.e., smoking cessation). A literature review by McBride, Koehly, Sanderson, and Kaphingst (2010) found that "genetic information based on single-gene variants with low risk probabilities has little impact-either positive or negative-on emotions, cognitions, or behavior" (p. 99). Fenech et al. (2011) state some factors they believe to be responsible for these results, including "methodological weakness of experimental designs to assess effectiveness and health literacy of the people likely to be receiving the advice" (p. 84). The health literacy of research participants in the current study was unknown; however, participants rated themselves as being familiar with their family medical history and also likely to change their dietary habits if provided with nutrigenomics information, particularly if they possessed an elevated risk for heart disease, cancer, or stroke.

In spite of these students perceived willingness to behavioral change in regards to their eating habits, the current study suggests that educating college students on nutrition, genetics, and nutrigenomics does not make them any more likely to change their eating habits than their peers who do not receive such information, given that there was no significant statistical difference between the experimental and control groups' survey responses. Furthermore, no significant differences were seen between the dietary habits of male and female college students. Results of this study are similar to research conducted by Bouwman (2009), in which the use of personalized nutrition advice in individuals' everyday lives was investigated. This research suggested that, in order to elicit behavior change, personalized nutrition information must combine with society's perspectives. In a society in which healthful foods are expensive, busy lifestyles are encouraged, and stressful conditions abound, it follows that healthy eating

may not be a societal priority. Along these same lines, those surveyed by Bouwman believed that "healthful eating is based on routines, should be uncomplicated, convenient and flexibly combined with eating for pleasure in everyday life" (p. 110). Clearly, this is not always experienced, given that healthful eating is often difficult and inconvenient. Finally, this study emphasized that health is not necessarily the first priority in an individual's life. Therefore, even though nutrigenomics research is available and has the potential to make a difference in a person's health status, they must believe it to be important in order for them to change their behavior.

Additionally, results of this study indicate that college students in this study did not change their eating habits in response to being provided with information about nutrition, nutrigenomics, and diet-disease relationships. However, students were not provided with specific information about their own genetic fingerprint, which would have made the information received more personalized and perhaps resulted in individuals experiencing a greater likelihood to change their eating habits. McBride, Koehly, Sanderson, and Kaphingst (2010) suggest that "personalized genetic information has its greatest impact on behavior when disease risks are appreciable" (p. 99). However, personalized information was not provided to research participants due to being beyond the scope of this research and also because of the lack of appropriate credentials held by the researcher. Furthermore, Prasad, Imrhan, and Rew (2011) warn that "we are not yet ready to provide personal nutrition advice to treat or prevent with a significant degree of confidence regarding most chronic diseases" (p. 167). Therefore, while providing personalized nutrigenomic information to study participants may have yielded more significant results, the science of nutrigenomics is not yet advanced enough to support such research.

Another major limitation of this study was that there was no way to match posttest survey responses with pretest survey responses. Had a code or some other method been used so that pre-survey and post-survey responses could be matched to a given research participant, the analysis of the survey responses may have been statistically significant. Another limitation was that participants were not provided with specific information on serving sizes, caloric needs, specific macronutrient needs, or nutritional meal plans; it is plausible that education in these areas could have better enabled the students to change their dietary habits. Also, the majority of students participating in this research were biology/pre-med and health sciences-related majors. Therefore, it is possible that these individuals were already engaging in healthful habits and were thus not as likely to change their dietary habits because a change was not warranted. Last, but certainly not least, the participants of this research were college students. Often, younger individuals are less willing than their parents and grandparents to make health changes, due to the fact that many of them have not yet experienced health-related illnesses and conditions.

In spite of the limitations present, the results of this study nonetheless illustrate the need for education that results in behavioral change. If individuals are presented with information that could potentially enable them to live a healthier, longer life and are yet unwilling to change their behavior, how does this information need to be presented in order to inspire individuals to change their habits in order to live a better life? Furthermore, this study also suggests that education must be individualized for a given person in order for them to be willing to make a change in their eating habits.

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APPENDIX A

Nutrigenomics Survey

1) Are you 18 or older? (check one)

   __________Yes __________No

   If no, please do not answer any further questions. You must be over 18 to participate in this research in order to eliminate the need for parental consent. Thank you very much for your participation.

2) You are a: (check appropriate gender)

   ________Male ________Female

3) What is your current class level? (check one)

   ________Freshman ________Sophomore ________Junior ________Senior

4) What is your current or intended major? (please write on the blank)

   ____.

5) How familiar are you with the current (within the past 5 years) medical and health conditions present in your family members? (circle one)

1	2	3	4	5	6	7
I do not know any of this information for my family						I know all of this information for my family

6) How familiar are you with the medical and health conditions previously encountered/ experienced (more than 5 years ago) by your family members? (circle one)

1	2	3	4	5	6	7
I do not know any of this information for my family						I know all of this information for my family

7) A vast amount of research is now available demonstrating how foods are used differently by the body depending on your genetic makeup and also how this can translate into a decreased risk of certain diseases and health conditions. Given this information, how likely would you be to change your current eating habits in order to combat health concerns later in life? (circle one)

1	2	3	4	5	6	7
I will not change my eating habits						I will change my eating habits

8) Suppose that your genes indicate that you have an above-average risk of developing heart disease, cancer, or experiencing a stroke. If you were told by a medical professional that eating a certain food would lower this risk, how likely would you be to follow this dietary advice? (circle one)

1	2	3	4	5	6	7
I wouldn't change any of my eating habits						I would always follow this advice

9) If you would **not** change your current eating habits, even if you knew that you could reduce your risk of medical concerns and diseases later in life by doing so, why not? (circle one)
   A. Question not applicable-I would eat different foods knowing this information.
   B. I will worry about and/or act on health concerns when they happen, not now.
   C. I do not believe there to be enough valid scientific evidence in this area to make me change my eating habits.
   D. I am not able to make changes in my eating habits.

10) How many *times per day* do you consume fresh, frozen, or canned fruit (examples: apples, pears, oranges, peaches, pineapple)? (circle one)

0	1	2	3	4	5	6	7
I do not eat this food daily							Seven times per day

11) How many *times per day* do you consume fresh, frozen, or canned vegetables (examples: spinach, green beans, tomatoes, carrots, cucumbers)? (circle one)

0	1	2	3	4	5	6	7
I do not eat this food daily							Seven times per day

12) How many *times per day* do you consume any type of meat, poultry, and/or fish (examples: beef, chicken, turkey, pork, fish)? (circle one)

0	1	2	3	4	5	6	7
I do not eat this food daily							Seven times per day

13) How many *times per day* do you consume "junk" foods (examples: cookies, potato chips, french fries, cake, ice cream, candy bars)? (circle one)

0	1	2	3	4	5	6	7
I do not eat this food daily							Seven times per day

14) How many *times per day* do you consume dairy products (examples: milk, cheese, cottage cheese, yogurt)? (circle one)

0	1	2	3	4	5	6	7
I do not eat this food daily							Seven times per day

15) How many *times per day* do you consume grain products (examples: cereal, pasta, bread)? (circle one)

0	1	2	3	4	5	6	7
I do not eat this food daily							Seven times per day

16) How many *times per day* do you consume processed foods (examples: canned ravioli, boxed mixes, frozen TV dinners, frozen pizza)? (circle one)

0	1	2	3	4	5	6	7
I do not eat this food daily							Seven times per day

You have completed the survey. Please turn in before leaving. Thank you so much for your time!

APPENDIX B

Nutrigenomics Handout

Nutrition 101

Carbohydrates: Provide energy for entire body (brain). Found in fruits, vegetables, grains.
Fats: Energy, energy storage, part of cell membrane. Found in oils, meats, many foods.
Protein: Part of muscle, bone, blood, hormones. Meat, peanut butter, beans are good sources.
Micronutrients ex: Sodium (acid-base, muscle); vitamin A (vision); vitamin C (antioxidant); vitamin D (bones).

Nutrient/Gene/Disease Interactions

Cancer: **Broccoli, cauliflower, onions.**

Cardiovascular Disease: **vitamin B (especially folate); found in green leafy vegetables, beef, mushrooms, oranges.**

Bone Diseases: **Calcium, vitamin D. Dairy products are a good source.**

Diabetes: **Currently being researched.**

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