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Increased dietary docosahexaenoic acid consumption and its effect on macular pigment optical density: the Eye Health in College-Age Students III pilot study

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Increased dietary docosahexaenoic acid consumption and its effect on macular pigment optical density: the Eye Health in College-Age Students III pilot study

by

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Abstract

Age-related macular degeneration (AMD) is a leading cause of vision loss in the United States and other Western nations. Docosahexaenoic acid (DHA) is a fatty acid that is important in maintenance of the macula, performing several protective functions. Associations between increased fish intake and decreased risk of AMD in young populations (ages 18-30y) have been shown in other studies, and supplementation of DHA in older adults has previously been successful in increasing macular pigment optical density (MPOD), a factor negatively correlated with AMD. In this study, it was predicted that in a cohort of normal weight, healthy young adults the consumption of fish high in DHA would increase MPOD. The current study supplemented 22 normal weight (BMI between 18.5 and 24.9kg/m2) and healthy young adults (18-28y) with meals containing an average of 80 mg of DHA per day for four weeks. MPOD was measured using a macular densitometer at baseline, two and four weeks. Data for participant characteristics and usual dietary intake were collected using a health history form; subject height and repeated weight measurements were made. Multivariate regression analysis was used to assess the relationship between gender and time on MPOD. One-way ANOVAs were used to analyze continuous variables to compare characteristics of males and females. It was determined that only height and weight were significantly different between males and females. Fruits and vegetable and seafood intake per week had no significant impact on MPOD. MPOD did not differ between males and females from baseline to four weeks. This study was a pilot to examine the effects of supplementation with DHA on MPOD in a healthy young adult population. In future studies a type of fish with a higher concentration of DHA per ounce, such as salmon, might be used for the intervention. Clear assessment procedures, increased sample size, increased frequency of weekly consumption of fish, can be explored for increasing the likelihood for seeing changes in MPOD.

Introduction

Age-related macular degeneration (AMD) is the leading cause of legal blindness in the United States (U.S.) and other Western nations. In 2010 over 2,000,000 adults 50 years and older in the U.S. had AMD, an 18% increase in prevalence in the degenerative disease since 2000[1]. This number increases dramatically when including individuals who have early AMD. In a forecast of AMD, the expected prevalence of individuals with AMD and early AMD is expected to grow from 9.1 million in 2010 to 17.8 million in 2050 if preventative therapies are not employed[1]. Internationally, AMD costs over $340 billion USD in loss of productivity and treatment costs for this disease[2].

It is common knowledge that good nutrition plays a role in maintaining general well-being including eye health. Presence and supplementation of carotenoids, precursors to vitamin A, have been shown to benefit eye health. Beta-carotene is commonly cited as a nutrient source that improves vision. In the eye, beta-carotene produces all-*trans* retinal, a factor in the production of rhodopsin for vision in low light that protects against radicals and other reactive oxygen species which result from oxidative stress and contribute to eye damage[3].

The carotenoid of interest in AMD, however, is the class known as the xanthophyll family represented by lutein and zeaxanthin. Xanthophylls are yellow pigments found in all plant leaves, and they absorb excess light and energy that chlorophyll cannot absorb. Xanthophylls are preferentially taken up by the retinal pigment epithelium, making up 80% of the retinal pigment. The physiological role of xanthophylls within the retina is not well known, but they apparently filter harmful blue light (as produced by fluorescent lights or electronics) and improve visual acuity[4;5].

Docosahexaenoic acid (DHA) belongs to a family of omega-3 polyunsaturated fatty acids. The precursor for DHA is alpha-linolenic acid (ALA), which is an 18-carbon fatty acid with three double-bonds, the first double bond occurring at the third carbon from the terminal methyl or "omega" end of the structure. ALA is considered an essential nutrient, because though its longer-chain derivatives are required for vital biological functions, including neurological functioning, the mechanisms for elongating shorter-chain omega-3 fatty acids to ALA are not present in humans. Due to the lack of the enzymes delta-12 and delta-15 desaturases humans are unable to efficiently convert oleic acid to ALA, and subsequently, other long-chain omega-3 fatty acids[6]. Further steps in the conversion of ALA to DHA occur through the elongation of and desaturation of ALA in the liver to EPA; the newly formed EPA then undergoes a series of steps to be metabolized to DHA. The conversion rate of EPA to DHA is very low in adults, therefore the consumption of fish, which already has the preformed DHA, is most effective in increasing DHA levels in humans[7].

Macular Pigment

The retina is the light-sensitive tissue located in the back of the inner eye. Within the retina, the macula is a structure posteriorly located in its center [8].The macula is the most sensitive area of the retina and contains the highest concentration of photoreceptors for light transmission, allowing for high-resolution visual acuity. Because of its density of photoreceptors, the macula is also responsible for central visual acuity. The macula contains several components—xanthophyll pigment and layers of ganglion cells, both of which are affected by diet[9]. Xanthophylls are a class of yellow pigment that is prevalent within the macula. The xanthophylls found in the retina are primarily lutein and zeaxanthin . These carotenoids are commonly found in foods which have a yellow or orange appearance with the exception of

vegetables high in chlorophyll, and they include corn, carrots, green leafy vegetables and egg yolks[10].

Omega-3 fatty acids play a role in the microvascular system of the retina, primarily in sensory conduction of light. DHA is found in greatest concentrations within the outer sections of photoreceptors. Typically, DHA makes up 1-5% of the fatty acid content of cell membranes in tissues, but within the outer rod segments of photoreceptors, DHA makes up approximately 50-60% of the fatty acids[6]. Dietary deficiencies of DHA reduce the speed at which rod photoreceptors, which are responsible for the detection of light, perform[11]. Specifically, DHA is significant in the regeneration of rhodopsin in visual excitation. In addition to aiding sensory conduction, DHA has significant roles in other retinal and photoreceptor functions including reducing rate of apoptosis, resynthesis of membranes in retinal outer segments, and differentiation of photoreceptors[6].

Age-Related Macular Degeneration

Through the Age-Related Eye Disease Study (AREDS) conducted by the National Eye Institute, a formal classification system has been created for identifying severity of AMD. This system consists of four categories: no AMD, Early Stage AMD, Intermediate AMD, and Advanced AMD, with subcategories of wet and dry advanced AMD[12]. The earliest signs of AMD occur with the detection of small drusen (diameter less than 63µm) within Bruch's membrane, an extracellular matrix located between the retinal pigment epithelium and the choroid[13;14] . Drusen are extracellular deposits that form below the retinal pigment epithelium in Bruch's membrane. They are characterized by their appearance as small yellow patches, primarily occurring in the macula, but drusen can also be present in peripheral areas of the retina. Drusen most resemble plaques found in Alzheimer's disease, with 24 known common molecular

constituents. These constituents include proteins and lipids thought to be derived from modified fats and protein produced by the retinal pigment epithelium, photoreceptors, and serum constituents[14].

Intermediate stages of AMD occur when there are extensive small drusen in both eyes, nonextensive intermediate drusen (diameter of 63-124 µm), or pigment abnormalities in at least one eye[12]. Pigment abnormalities occur when cells of the retinal pigment epithelium degenerate. Degeneration of tissue within the retinal pigment epithelium is normal with age-related alterations, but degeneration can be exacerbated by oxidative stress. The oxidation which occurs in the tissue's melanin has been attributed to a complex formation between melanin and lipofuscin. This complex results in a reactive oxygen species that, when excited by blue light, increases vulnerability of the retinal pigment epithelium to oxidative stress[15].

Adults with advanced AMD suffer from the presence of large drusen (diameter greater than 124µm), as well as vision loss from damage to the macula. Advanced AMD has two subcategories: wet and dry[12]. Dry AMD, also known as AMD with geographical atrophy or non-exudative AMD, is related to the formation of drusen on the retina. Depositions of drusen increase the thickness of Bruch's membrane, which effectively decreases the flow of nutrients across this structure. As a result, apoptosis increases and abnormal cell proliferation occurs in the retinal pigment epithelium. Instead of a monolayer of pigmented cells, there are alternate areas of hyperpigmented, multinucleate cells and hypopigmented areas. Regions of extensive cell loss in the retinal pigment epithelium are classified as geographical atrophy [16]. The second subtype of advanced AMD is known as wet AMD. Formally this subtype of AMD is known as neovascular, or exudative AMD. In a process called choroidal neovascularization, abnormal angiogenesis occurs in the choroid of the eye and proliferates through Bruch's membrane

towards the retina. These abnormally formed blood vessels tend to leak and cause vision loss, primarily affecting central vision [17].

Risk Factors

AMD is multifactorial in nature, with genetic, environmental, and behavioral influences contributing to its occurrence. Genetic associations of AMD were first described in 2003, when the degenerative disease was linked to multiple chromosomal loci[18]. Several complement-related genes, such as complement factor H (CHF), have been identified as modifiers of risk for AMD. These genes contain variants of alleles and haplotypes that suggest increased susceptibility to AMD, including Y402H, a variant of the CHF gene[19]. Conversely, there are allele and haplotype variants that have been reported to have a protective affect against AMD[20]. Age is a recognized risk factor for AMD, with prevalence increasing exponentially after 50 years of age. According to data collected by the National Eye Institute in 2010, the prevalence of AMD increases from 0.36% of the adult population between ages 50-54y to 11.73% of adults older than 80 years[1]. Racial differences exist in the occurrence of macular degeneration, though these differences are not fully understood. In a retrospective longitudinal cohort study including data from 2001-2007, racial minorities (e.g. African American, Latino, Asian American) were diagnosed with exudative and nonexudative AMD at a reduced rate compared to European Americans. A recent study in Norway found associations between modifiable behaviors and AMD. Smoking, an activity known to increase oxidative stress, was strongly related to diagnosis of AMD, as were elevated systolic blood pressure, physical inactivity, and being overweight or obese[21]. Other risk factors for AMD are dietary, including low intake of antioxidants including vitamins C and E, beta-carotene, and zinc[22].

Gender Differences in AMD

Women make up over two-thirds of all AMD cases in the United States [1]. Studies in young adults as well as older adults have shown that women tend to have lower MPOD than men, making them a prime target for possible intervention. In a study assessing MPOD of young, healthy Southeast Asians, MPOD was found to be significantly lower in women than men (MPOD 0.41±0.14 vs. 0.47±0.13, $p<0.01$)[23]. This trend has been seen in other AMD research, with dietary factors potentially playing a role in MPOD differences between genders[24].

The ongoing Eye Health in College-Aged Students II study has found that women not only tend to consume less omega-3s in their typical diets, but they also have a greater preference for consuming seafood that is low in omega-3 fatty acids compared to men[24].These findings are supported by longitudinal studies that have found associations between consumption of omega-3 fatty acids and fish and reduced risk of AMD. As reported by the Women's Health Study, greater intake of DHA and EPA, as well as consumption of 1 or more servings of fish weekly was associated with a lower relative risk of AMD when compared to women who consumed less than 1 serving of fish per month [25]. In the National AMD Treatment 2 Study (NAT2), patients with neovascular AMD had significantly lower intake of dietary oily fish and seafood[26]. Data from semi-quantitative food frequency questionnaires completed by an elderly Australian cohort enrolled in the Blue Mountains Eye Study showed associations between fish consumption and long-chain omega-3 intake. Participants who consumed one serving of fish per week had a lower relative risk of 0.69 (0.36-0.9) for developing AMD. There was a trend towards lower risk of early AMD with higher intake of total long-chain omega-3 fatty acids[27].

Intervention Studies

Dietary interventions to reduce risk of macular degeneration have focused on supplementation with a combination of xanthophylls (lutein and zeaxanthin) and omega-3 fatty acids. In an intervention conducted by Arnold et al. on the effects of xanthophylls and omega-3 fatty acids, researchers were able to see improvements in macular pigment optical density (MPOD) in as little as one month [28]. Participants were randomized and placed into three groups—placebo, supplementation with a capsule containing 10 mg of lutein, 1 mg of zeaxanthin, 100 mg of DHA, and 30 mg of eicosapentaenoic acid (EPA), and supplementation with a capsule containing twice the amount of each nutrient daily for 12 months. At the end of the study, both groups of participants who received supplementary capsules had higher MPOD when compared to the placebo (p<0.05). Increases in macular pigment occurred by the end of the first month and remained constant, with larger increases in MPOD in participants taking capsules containing twice the amount of nutrients [28].

In a randomized trial, Garcia-Layana et al. supplemented with xanthophylls and omega-3 fatty acids to assess the effect of supplementation on MPOD in patients with early AMD. In their study, patients given a supplement containing 12 mg of lutein and 280 mg of DHA daily were compared to patients receiving a placebo. The difference in mean MPOD increases was significantly different after one year (p<0.05), suggesting that lutein and DHA supplementation could be effective in protecting against the progression of AMD [29]. In the intervention phase of the NAT2 study, researchers supplemented patients between the ages of 55-85 y with early AMD lesions daily with a capsule containing either 840 mg of DHA and 270 mg of EPA or a placebo containing olive oil for three years. Patients who received these supplements showed significant increases in MPOD after the intervention[26].

AMD is a degenerative disease whose onset can be delayed or prevented by the intake of nutrients including lutein, zeaxanthin, and long chain omega-3 fatty acids. Though data show that increased omega-3 fatty acid consumption has been associated with an increased macular pigment, most intervention studies have been with supplements and not whole food. In addition, most interventions have been conducted with populations who were in middle or late stages of life or who already showed signs of AMD. The current study aimed to assess the impact of consuming fatty fish on MPOD in healthy young adults (18-28y). In addition, based on the evidence showing that women not only consume lower quantities of fatty fish and have lower MPOD [23;24], it was hypothesized that women might obtain greater benefits from this intervention in terms of MPOD.

Research Hypothesis

In a cohort of normal weight (BMI between 18.5 and 24.9kg/m^2), healthy young adults (18-28y), supplementation of DHA through diet will increase MPOD.

Methods

The study, consent form, and all associated materials were approved by the Institutional Review Board of the Louisiana State University AgCenter.

Study Design

The Eye Health in College-Aged Students III study was a single-subject longitudinal design.

Participants

Participants included 22 normal weight adults (mean BMI= 22.3±1.7kg/m^2) between the ages of 18-26 years (mean age= 20.95±2.19). The sample consisted of both males (*n*= 8, 36%)

and females (*n*=14, 64%). Participants were recruited within two weeks in January 2014 from the Baton Rouge area through social media, contact of individuals, showed prior interest in participating in research at LSU, and in-person invitations to the study. Inclusion criteria for participants in this study included willingness to consume a provided lunch three times a week for four consecutive weeks, not smoking, and BMI between 18.5 and 24.9kg/m^2. Exclusion criteria for this study included age below 18y or over 28y, a BMI <18.5 or >24.9kg/m^2, history of eye disease, pregnancy or diabetes, consumption of over six alcoholic drinks per week, and smoking. All participants received compensation of free lunches from the study and a stipend of $50 upon completion of the study.

Procedures for Intervention

The present study was a longitudinal design. It was conducted at Knapp Hall at Louisiana State University (Baton Rouge, LA) for four weeks. Prior to the dietary intervention, all participants completed a health history questionnaire for health history, food intake patterns, including intake of fruits, vegetables and seafood, and barriers to consumption of fruits, vegetables or seafood [Appendix A]. Participants were weighed at baseline using a digital platform scale (TBF-300A Tanita Body Composition Analyzer, Tanita, Arlington Heights, LA). Height was measured to the nearest 0.125 inch (1/8^{th} inch) using a stand-alone stadiometer (Shorr Productions, Olney, Maryland). BMI was calculated as weight (kg) divided by height squared (m^2).

Macular pigment optical density (MPOD) was measured by heterochromatic flicker photometry through the use of a macular densitometer (Macular Metrics, Rehoboth, MA). Heterochromatic flicker photometry is considered the standard by which MPOD is assessed. This technique compares the luminances, or intensities, of two light sources (blue and green

wavelengths) using a circular field. When the luminances do not match, a flicker in the circular field is apparent. However, when matching the brightness of these differing luminances, elimination or minimization of the flicker occurs. The readings of the luminances result in a ratio of thickness between the fovea and peripheral areas of the retina[30].

Macular pigment optical density was determined using the protocol published by Wooten[31]. In brief, participants were first instructed by video on how to operate the densitometer as a subject. Topics in the video included previews of the stimuli to be seen, how to turn the subject knob to increase or decrease flicker, finding the center of their "no-flicker zone", and troubleshooting answers to issues commonly encountered while using the machine. A trained researcher allowed the participant to view the stimulus measuring central macular pigment. The Low Flicker Frequency (LFF) was determined by adjusting the intensity of a test wavelength that is absorbed by the macular pigment. Once LFF was recorded, the researcher "reset" the subject knob so that the inner circle of the blue light stimulus would flicker again. The participant then found the center of where flicker elimination or minimization occurred until 10 scores that differed within a range of 100-500 were obtained. The process of finding the LFF and 10 values within a range of 100-500 was repeated with another stimulus that measured peripheral macular pigment. The resulting numbers were entered into a formula to calculate the log ratio of (central/peripheral) and MPOD as well as standard deviation (SD)[31].

For the intervention, all participants consumed lunch at Knapp Hall three days per week in preassigned shifts between 12:30 pm and 2:00 pm for four consecutive weeks. Participants were grouped into teams based on lunch availability, and consumed lunch in a communal setting with the 6-9 participants who also chose that time frame. Participation was monitored through attendance records at each meal time. Additionally, all foods consumed were noted on

a lunch survey to ensure that all components of the meal (tuna fish and supplementary items including bread, crackers, fruits and/or vegetables) were consumed. The availability of certain fruits and vegetables were rotated on a weekly basis and included bananas, apples, oranges, pineapple, carrots, celery, broccoli, and cherry tomatoes. Additional items available for consumption included peanut butter and jelly sandwiches in the event that participants remained hungry after consuming the tuna. Lunch was presented in a self-serve manner, in which the participants received their portion of tuna, but were able to choose which fruits, vegetables, drinks and condiments they wanted.

Researchers calibrated the scale prior to each lunch and measured 84 g of canned light tuna for all participants. Trained researchers also set up the dining area, prepared fruit and vegetables that needed cutting, and monitored participant intake to ensure that portions of tuna were consumed entirely. Using the nutrient analysis program Nutrition Data System for Research 2013 (NDSR 2013; University of Minnesota, Minneapolis, MN), the DHA content of the tuna fish was analyzed. Intake of 84 g of drained, light tuna provided 187 mg of DHA per serving, or a total of 561 mg of DHA per week, which averaged to an intake of 80 mg of DHA per day. At weeks two and four, participant weight and MPOD were re-measured.

Statistical analysis

Data were analyzed with JMP 10 statistical software (SAS Institute Inc., Cary, NC). Means and standard deviations for the continuous variables age, weight, height, BMI, MPOD, fruits and vegetable servings per week, and seafood servings per week were calculated. Analysis of Variance (ANOVA) was used to evaluate mean differences between males and females for continuous variables. Frequencies and percentages were used to compare differences between

males and females for the categorical variables of gender, eye color, and ethnicity. Multivariate regression analysis was used to evaluate gender differences in MPOD over time.

Results

Of the original 22 subjects enrolled in the study, four participants were excluded prior to analysis. Among the excluded, two participants voluntarily withdrew from the study for reasons related to health and food preferences and two other participants were dropped from the study for failure to show up at a meal. Failure of study examiner in following operating procedures for the assessment of macular pigment optical density led to the exclusion of seven participants. The final sample size was 11 participants, with 4 males and 7 females. Characteristics of the population are provided in Table 1. Data for time point two weeks were removed because of examiner error.

Of the continuous variables measured, it was determined that only height and weight were significantly different between males and females (Table 1). Fruits and vegetable and seafood intake per week had no significant impact on MPOD. MPOD was not different between males and females from baseline to four weeks (Table 2). Upon completing a power calculation, we determined the study had limited power of 8% due to the small sample size in both groups. Gender, time, and gender x time explained only a small portion of the variance in MPOD (R^2=0.03, p=0.83).

Discussion

Assessment of MPOD in a young population is of great interest and importance in eye health research because cases of AMD are expected to double by the year 2050[1]. If this occurs, the cost of treatment and productivity of AMD will become an even bigger burden on the US economy and the economies of other Western countries. Preventative action in a young

population could maintain macular health and potentially reduce the incidence of AMD. Associations between increased fish intake and decreased risk of AMD in young populations (ages 18-30y) have been shown in other studies [23,24]. Other studies have generated evidence for efficacy of consuming cold water fish to reduce risk of AMD in older populations[25-27]. Clinical data would provide the evidence required for dietary recommendations to increase cold water fish intake early in life for preventing AMD.

In the literature, there is a positive association between the supplementation of omega-3 fatty acids, particularly DHA, in interventions and the improvement of MPOD in older populations [26, 28, 29]. The results of the current study do not support these previous findings. It was found there was no significant influence of supplementation of DHA (through consumption of fatty fish) on MPOD in a young population. Typically in diet intervention studies for AMD, study subjects have shown initial stages of AMD and have been older.

The current study differed from the aforementioned studies[26,28,29] in having a group of young adults between the ages of 18-28y who had no history of eye disease or early AMD. The method of providing DHA also differed. In this study, supplementation of DHA through consumption of fish was utilized instead of capsules with omega-3 fatty acids.

The intervention effects reported in other studies[26, 28, 29] might be attributed to a response from existing macular vulnerability. In interventions testing impact on chronic illnesses, dose response can be dependent on the disease state of the individual. For example, in the testing of the DASH diet, both groups (hypertensive and non-hypertensive) experienced changes in systolic and diastolic blood pressure. However, in the hypertensive group, effects of the intervention were significantly greater than those seen in the healthy group [32]. Likewise, intervention for MPOD may have only modest effects in a young and healthy population, but

significant effects on a population at risk for the disease. This cannot yet be confirmed because the current study was limited in several ways including number of subjects and loss of subjects. Length of intervention and the frequency of fish consumption should be explored in a future study of young adults.

Limitations

There were several study limitations. The sample size of participants was very limited, and thus the results shown here may not be typical of the adult population between the ages of 18-28 years. Technical inconsistences by researchers resulted in data points being excluded, further limiting the sample size and findings and conclusions.

Lessons Learned

Through the course of completing this pilot study, several points of importance were learned. Recruitment, even with a limited amount of funds, needs to be conducted well in advance to obtain a large sample size. Ensuring experimental and technical homogeneity among the researchers is something that must be done prior to conducting the study, even when all researchers collecting data have had previous experience using the study equipment. Group collaboration and schedule maintenance are important in creating an environment in which the study can run smoothly and unexpected incidents are able to be addressed in a timely manner. In completing a successful intervention study, there is also a need to communicate procedure to subjects and establish that they understand to ensure accurate and reliable measurements.

Future Research

This study was a pilot to examine the effect of supplementation with fish high in DHA on MPOD in a healthy young adult population. To gain a better understanding of the relationship between DHA and MPOD in this population, this study should be repeated with training of researchers with attention to assessment procedures and clear instructions to subjects. Increased sample size can increase the power of the results. Increasing the length of the study or frequency of fish consumption per week could increase the likelihood for seeing changes in MPOD. Future studies could choose to intervene with a type of fish that has a greater concentration of DHA per ounce, such as salmon. This would allow for recommended portion sizes of fish to be consumed while providing more of the active nutrient.

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Table 1. Descriptive characteristics of Eye Health Study III participants

Characteristic	Male (n=4)	Female (n=7)
Age	21.5±3.4	20.1±2.3
Height (inches)	67.4±1.5	61.8±3.0*
Weight (pounds)		
Baseline	147.3±17.2	122.2±15.6*
Week 4	149.5±15.5	127.3±16.6
BMI (kg/m^2)		
Baseline	22.8±2.0	22.5±1.8
Week 4	22.5±1.8	22.3±1.7
MPOD		
Baseline	0.32±0.06	0.42±0.16
Week 4	0.39±0.13	0.40±0.20
Fruit/Veg Per Week	14±17.5	10.3±6.5
Seafood Servings per Week	1.75±1.1	2.9±2.3
Ethnicity		
White	3 (75%)	2 (29%)
Black	0 (0%)	5 (57%)
Hispanic	0 (0%)	0 (0%)
Asian	1 (25%)	1 (14%)
Middle Eastern	0 (0%)	0 (0%)
Eye Color		
Brown	2 (50%)	5 (71%)
Blue	1 (25%)	1 (14%)
Green/Hazel	1 (25%)	1 (14%)

Values were significantly different between genders ($p<0.05$*)

Table 2. MPOD is not impacted by gender and duration of DHA intervention

	Beta Estimate	**Std. Error**	**Prob >|t|**
Intercept	0.3821	0.03387	<0.001
Gender	0.0283	0.03387	0.4099
Time	-0.0116	0.03387	0.7348
Gender x Time	0.0196	0.03387	0.5672

R^2 = 0.03, *p*=0.82

Appendix A. Health History Form

Health History Form

Name: _____ Code #: _____

Date: _____

Age: _____

Weight: _____ lbs. (to be completed by investigator)

Height: _____ inches (to be completed by investigator)

BMI: _____ (to be completed by investigator)

1. Ethnicity (check one):

   - ☐ American Indian or Alaska Native
   - ☐ Asian
   - ☐ Black or African American
   - ☐ Native Hawaiian or Other Pacific Islander
   - ☐ White
   - ☐ Hispanic or Latino
   - ☐ Others (specify): _____

2. Eye color:

   - ☐ Blue
   - ☐ Brown
   - ☐ Green
   - ☐ Hazel
   - ☐ Black

3. Do you have a family history of eye disease? _____Yes _____No

   If yes, name disease if known _____

4. Have you been diagnosed with eye disease? _____ Yes _____ No

   If yes, name disease _____

5. Do you have high cholesterol? _____ Yes _____No

6. Do you have high blood pressure? _____ Yes _____No

7. Do you have any other health conditions not mentioned above? (For example, have you been diagnosed with diabetes, hyper/hypo -thyroidism, heart disease, etc.?)
   _____ Yes _____ No

   If yes, please list: _____

8. Do you smoke cigarettes, cigars or pipes? _____ Yes _____ No

   If yes, how many per day _____ per week _____ per month _____

9. Do you drink alcoholic beverages? _____ Yes _____ No

   If yes, how many per day _____ per week _____ per month _____

10. Do you use any nutritional supplements? _____ Yes _____ No

    If yes, which ones? (Include brand name if known)_____

11. Do you eat most of your meals away from home? _____ Yes _____ No

    If yes, where do you usually eat? _____

12. How many times do you eat fruits and vegetables?

    _____ per week

    (or) _____ per month

    (or) _____ per year

13. List the fruits and vegetables most commonly eaten

    1._____

    2._____

    3._____

    4._____

14. Below, please circle the fruits and vegetables that you eat:

Kale	Brussels sprouts
Turnip Greens	Green Beans
Collards	Tangerines and tangerine juice
Spinach	Oranges and orange juice
Broccoli	Okra
Corn	Celery
Peas	Tomatoes and Tomato juice
Romaine Lettuce (also called	Melons
cos lettuce)	Peaches
Carrots	Papayas

15. How many times do you eat seafood (fresh, frozen or canned)?

    _____ per week

    (or)_____per month

    (or) _____per year

16. List the type of seafood most commonly eaten (if fish, what kind, example: salmon or catfish?)

1._____

2._____

3._____

4._____

17. Do you eat sushi? _____ Yes _____ No

    If yes, what type of sushi do you usually eat? (example: Sashimi, California roll)

    _____

18. If you don't consume fresh fruits and vegetables frequently what are the main reasons?

    - ☐ Too expensive
    - ☐ I don't know how to prepare them
    - ☐ I don't buy my own groceries
    - ☐ I don't like them
    - ☐ They don't have long shelf life
    - ☐ Other:_____

19. If you don't consume seafood frequently what are the main reasons?

    - ☐ Too expensive
    - ☐ I don't know how to prepare them
    - ☐ I don't buy my own groceries
    - ☐ I don't like them
    - ☐ They don't have long shelf life

Other:_____

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