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An Investigation of Dietary Supplementation as a Potential Source of Nutrition Misinformation Hindering the Development of Healthy Eating Habits in th College Population

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**AN INVESTIGATION OF DIETARY SUPPLEMENTATION AS A
POTENTIAL SOURCE OF NUTRITION MISINFORMATION
HINDERING THE DEVELOPMENT OF HEALTHY EATING
HABITS IN THE COLLEGE POPULATION**

by

Mary Dimmick

**Thesis submitted in partial fulfillment
of the requirements for the degree**

of

DEPARTMENTAL HONORS

in

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in the Department of Nutrition, Dietetics, and Food Science**

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ABSTRACT: Current dietary supplement legislation allows nutrition misinformation to flourish; misleading structure-function and health-claims now abound on supplement labels. Meanwhile, college students tend to be open to experimentation and exploration. Hence, this study's objective was to discover if students at USU are being influenced by such claims to unjustifiably take dietary supplements in a manner which hinders the development of healthy eating habits. During August of 2009, 1,300 USU freshmen were invited to voluntarily participate in an on-line survey concerning dietary patterns which included a section about dietary supplementation. Five-hundred-and-twelve completed the survey after providing informed written consent to participate. The majority of participants were 18-years-old and Caucasian. Thirty-five percent of students reported taking at least one dietary supplement; the most common being a multivitamin. Popular reasons for supplementation included improved health and muscle augmentation. Also, 51% of supplement users reported family members as their source of supplement information. While no significant difference existed between the dietary patterns of supplement and non-supplement users, the efficacy of supplementation practices was questionable. Ultimately, considering the circumstances of college life and the prevalence of dietary supplement use among college students, on-campus nutritional professionals should be actively engaged in educating students about dietary supplements.

Introduction

Current dietary supplement legislation enables nutrition misinformation to flourish.

Without mandatory pre-market approval, misleading structure-function and health-claims now abound on supplement labels. Meanwhile, college students tend to be open to experimentation and exploration. Therefore, the dietary habits of the college population may be especially vulnerable to such misinformation.

The Rise of Food and Nutrition Misinformation

In 2006, the American Dietetic Association (ADA) published a position paper in the *ADA reports* which declared, "Food and nutrition misinformation can have harmful effects on the health, well-being, and economic status of consumers." (1) This statement was followed by the association's urgent call for its members as nationally credentialed dietetics professionals to oppose food and nutrition misinformation in its many shapes and forms and at its various sources. What prompted the ADA to address the issue of nutrition-related misinformation?

The answer to this question can be found within that 2006 position paper, and is summarized by the following statements: As consumers are increasingly taking control of their self-care, they are becoming more interested in the link between nutrition and health; deceptive information concerning food and nutrition is potentially harmful and costly to society; and food and nutrition misinformation is on the rise. (1)

First of all, in this era of consumerism, our society appears to be seeking information and products which supposedly support self-treatment of health problems, and sustain the long-term avoidance of healthcare professionals. Meanwhile, the recent and substantial increase in scientific advances with regards to the nutrition-health link has made nutrition a spotlighted topic throughout the media. Consequently, consumers are more susceptible to the misleading, unscientific, expedient, and occasionally spiteful influences of food and nutrition misinformation. (1)

While sound nutrition information is based upon solid scientific research processes, consumers have reported that they acquire most of their information concerning nutrition from the media, (i.e. television, the internet, magazines, books, and newspapers). (1) Since the media is notorious for highlighting preliminary research results in order to spark and maintain the interest of patrons, the American society is often flooded with incomplete, unbalanced, and confusing blurbs of food and nutrition misinformation instead. (1) Furthermore, countless advertisements within the media contain testimonials and unrealistic promises touting too-good-to-be-true products which appeal to the American desire for “quick-and-easy” solutions to any problem. (1) Other typically less self-serving sources of food and nutrition misinformation include friends, family, and cultural traditions and customs. Such sources may

have an inquiring individual's best interest at heart, but may also be tainted with erroneous knowledge acquired from the media, outdated research findings, or unscientific belief systems. Indeed, as the ADA purports, dietetics professionals are the most reliable source of food and nutrition information, however, data collected via the ADA's *Nutrition and You: Trends 2002* survey and the Food Marketing Institute showed that only 13% of consumers reported receiving such information directly from a registered dietitian (RD). (1) Consequently, the ADA has encouraged its members to "diligently work with other health care practitioners, educators, policy makers, and food and dietary supplement industry representatives to responsibly address the health and psychological, physiological, and economic effects of nutrition-related misinformation." (1)

Another apparent reason why the ADA has elected to make an aggressive stand against food and nutrition misinformation is that the association recognizes the negative effects and high costs which false information pertaining to nutrition may inflict on the American society. As the fact that nutrition status is significantly related to overall health and well-being has been well established, it is clear that food and nutrition misinformation in its various forms, (i.e. misdirected claims, health fraud, food faddism, etc.), has the potential to diminish the efficacy and/or distract the efforts of consumers to adopt healthier eating habits and lifestyles. (1) In short, food and nutrition misinformation poses a threat to the physical health of consumers. The truth to the previous statement is only magnified when the issues of delayed proper healthcare measures, possibly hazardous unforeseen drug-nutrient interactions, or undetected toxic components of food are considered. (1,2) Furthermore, when individuals are fooled by food and nutrition misinformation, they may reject reliable nutrition education and credible

nutrition-related information sources. In addition, after experiencing failure, or being exposed to fraudulent products and information which inspire hope for a convenient, low-cost solution to a problem, an individual may feel inadequate to achieve a healthy lifestyle on his or her own.

(2) Therefore, food and nutrition information also may compromise psychological health to some degree. (1) Lastly, the economic status of a naïve consumer is also at risk when exposed to nutrition-related misinformation, as those who initially present misleading information to the public are often profit-seeking. For example, in 2004, \$43 billion was generated by sales of weight loss solutions alone, a very alluring figure to any greed-driven individual. (1) Meanwhile, according to the Center for Disease Control's (CDC) website, obesity rates following 2004 rapidly increased; it appears that the billions of dollars spent on weight loss solutions purchased, at most, a very insignificant amount of successful weight loss.(3) Needless to say, the negative physical, psychological, and economical consequences of food and nutrition misinformation are evident in today's society. However, many consumers remain oblivious to the gross amount of nutrition-related misinformation they encounter on a daily basis, and the prevalence of food and nutrition misinformation continues to rise.

At this point, food and nutrition misinformation has been established as a multifaceted, formidable enemy of the well-being of consumers. Thus, the question now becomes, "Why is this issue becoming increasingly prevalent throughout our society?" There are several explanations for this unfortunate trend, such as the ignorance of consumers or the greed of self-serving political and business leaders. However, the ADA seems to especially attribute the rise in food and nutrition misinformation to one phenomenon in particular--- the rapid development of the dietary supplementation industry. The reality is, as clearly stated in the

ADA's 2006 position paper, that the dietary supplementation industry has, "out-paced federal regulation." (1).

Federal Regulation of the American Dietary Supplement Industry

Prior to the 1990s, dietary supplementation was not a popular practice in the United States. It was the establishment of the Office of Alternative Medicine, (now known as the National Center for Complementary and Alternative Medicine (NCCAM), within the National Institutes of Health in 1991 that marked the true beginnings of the multi-billion dollar, dietary supplement industry. (2) According to Pray W.S., critics of NCCAM argue that the organization's creation, which was accomplished largely by the efforts of two senators--- one who believed bees wax ameliorated his allergies and another who thought that colostrum from a Minnesota cow's milk could cure Lyme Disease--- was simply a governmental ploy to divert the financial funds of legitimate medical research to the development of unproven therapies, including unproven medications; unproven medications can be defined as medications for which the safety and efficacy are not backed by sufficient scientific data.(2) Interestingly, Pray W.S. has also provided an evidenced-based argument that the terms "dietary supplement" and "unproven medication" may now be used interchangeably. (2) This may be greatly attributed to the virtual deregulation of the dietary supplement industry as a result of the passage of the Dietary Supplement and Health Education Act (DSHEA). (1,2)

In 1994, the honorable Senator Orrin Hatch of Utah and representatives from the health food industry, successfully backed the passage of a very influential piece of legislation entitled The Dietary Supplement and Health Education Act, commonly known as DSHEA. By doing so, the senator and his constituents effectively shifted the burden of proving the safety and

efficacy of dietary supplements from manufacturers to the United States Food and Drug Administration (FDA) by mandating that supplements be regulated separately from food and medication. As tens of thousands of dietary supplement products have since flooded the market, the FDA, even with the assistance of the Federal Trade Commission (FTC), has simply not been able to keep up with the growth of the industry.(2)

While \$8.8 billion were collected by the dietary supplement industry in 1994, by 2003, sales had increased by more than 100%, reaching \$18.8 billion. What many consumers may not realize is that, due to DSHEA, dietary supplements may be introduced for sale in the market without being reviewed by the FDA, and, consequently, any product with the designated “dietary supplement” disclaimer may be marketed, even if it lacks evidence backing its safety or efficacy.(1,2,4) In addition, while the Bureau of Consumer Protection of the FTC has declared its objective is to “protect consumers against unfair, deceptive, or fraudulent advertising practices”, they have also voiced that policing such practices is no less than an overwhelming task, as countless advertisements are now hidden on the internet.(2) It appears that the agency has only successfully filed charges in the most serious cases. Hence, the ADA has declared that DSHEA may have “inadvertently” accredited food and nutrition misinformation, as the federal government is struggling to identify and review the numerous faulty claims floating through the media. (1) Even further, because DSHEA has enabled the dietary supplement industry to market products that are not backed by sufficiently established evidence of being safe and effective, it becomes challenge for the FDA to remove products from the market after allegations have been made.(2,4)

In his editorial for the Mayo Clinic, Lindsay B. called for his fellow physicians to lobby for the passage of legislation that would thwart the introduction of clinically unproven dietary supplements after highlighting a fundamental flaw in DSHEA. He purported that because the legislation in question allows manufacturers to market dietary supplements lacking evidence of safety and efficacy, the supplement industry is now set up to evade the efforts of federal regulators to effectively remove harmful and deceitful products from the consumer's reach. When the FDA receives or instigates allegations against a supplement, evidence must be provided to strip the product off the market. However, as a result of DSHEA, often times, there is no evidence of the product's safety and efficacy in the first place, and producers of the supplement argue that there is a lack of evidence that their product is unsafe.(5)

For example, a case illustrative of this dilemma involved the chemical stimulants ephedrine alkaloids, which were popularly used to enhance athletic performance or assist weight loss in the late 1990s. In June of 2000, FDA proposed that the following actions should take place after having received recommendations of the working group as well as reports of serious injury and death of athletes who were using ephedrine alkaloids: The dosage and timeframe of the supplementation of ephedrine alkaloids be limited; a warning label should be required on the products containing the stimulant and inaccurate labeling claims prohibited; and the use of ephedrine alkaloids in dietary supplements containing stimulatory ingredients such as caffeine should be prohibited. Ultimately, the latter proposal was the only regulatory action that was not withdrawn secondary to the high rate of criticism the FDA faced from consumers, independent distributors of ephedrine alkaloid products, and the General Accounting Office, which was instructed by the House Committee on Science to assess the

scientific basis of the FDA's concerns toward ephedrine alkaloids. While the General Accounting Office concluded that the concerns of the FDA were reasonable, it deemed that because recommendations were heavily-based on information obtained via Adverse Event Reports, not scientific evidence, they were only questionably legitimate. Interestingly, Lindsay B. also highlights in his editorial that two independent groups of researchers have conducted similar studies pertaining to the Adverse Event Reports which led the FDA to make its proposals which generated comparable results.(5)

The first study was conducted by Samenuk et al, which identified 37 serious cardiovascular events, 11 of which were linked with sudden deaths, occurred in the patient population taking ephedrine. The second study was conducted by Haller and Benowitz and found that of 140 adverse events including hypertension, palpitations, stroke, seizure, death (in 10 cases), and permanent disability (in 13 cases), 31% were probably related to ephedrine alkaloids, while an additional 31% were possibly related. Furthermore, 500 adverse event cases were reported by the Texas Health Department between 1993-1995 involving myocardial infarction and stroke in patients taking ephedrine alkaloids. Regardless, no direct causal relationship was found between ephedrine and the adverse cardiovascular events.(5) More recently, in 2004, the FDA prohibited the sale of the popular weight loss supplement, Ephedra, due to the risks the stimulatory supplement poses to users' cardiovascular and central nervous systems. Not surprisingly, Ephedra has remained on the market while the numerous legal appeals which were made against the FDA's allegations and legislation are pending.(2,5) Indeed, it is unmistakable that because DSHEA has provided the dietary supplement industry the opportunity to market products without performing scientific clinical trials assessing safety

and efficacy, restriction or prohibition of potentially dangerous and/or ineffective dietary supplements by the FDA becomes extremely challenging. In short, DSHEA effectively deregulated the dietary supplement industry, thereby exposing consumers to harmful and/or wasteful products. The latter statement appears to be the consensus in the healthcare community as illustrated by the following statement made by an esteemed physician: “Under current law, I could literally pack capsules full of grass clippings from my lawn and market them as just about anything I liked.”(2)

Emerging Dietary Supplement Control Measures

While there is no doubt that the dietary supplement industry is loosely regulated at best, in recent years, the FDA and other entities have taken steps in the right direction to control the quality of dietary supplements marketed to consumers. For example, on the USDA’s website now contains a FDA component called “Medwatch” which may be used by consumers to report adverse events related to dietary supplement use.(6) This voluntary reporting system may act as a good resource for those considering taking a certain dietary supplement. Furthermore, with the emergence of Current Good Manufacturing Practices (GMPS) in 2006, the FDA now has the final say about the quality standards that supplement manufacturers need to abide by one producing such products.(7) Indeed this is a step in the right direction, however, the supplement industry remains too vast for such control measures to effectively reach all manufacturers, distributors, and retailers of dietary supplements. With DSHEA still in effect, the amount of products on the market still presents the FDA with a nearly impossible challenge as resources are limited.

A Closer Look at Dietary Supplements

According to the Dietary Supplementation Act of 1994, the term “dietary supplement” encompasses products meant to supplement the diet, (not including tobacco), which are composed of one or a combination of the following ingredients: “A vitamin, a mineral, an herb or other botanical, an amino acid, or a dietary substance for use by man to supplement the diet by increasing the total dietary intake, or a concentrate, metabolite, constituent, [and] extract.”(8) For the purposes of this discussion, vitamin and mineral, herbal/botanical, amino acid/performance enhancing, and weight loss supplements will be highlighted as well as how these products impact, or “supplement”, the diets of consumers.

Herbal/Botanical Supplements

The use of herbs, (plants or components of plants), for medicinal and self-treatment purposes has been practice throughout the history of humankind. Just as the ancient societies once did, our society today utilizes the roots, bark, flowers, leaves, stems, and other parts of plants from our surrounding environment with the belief that various health benefits will result.(9) With the organization of NCCAM and the passage of DSHEA, the growth of the herbal industry has increased immensely; sales of herbal supplements have been exceeding \$3 billion per year and recently there has been a yearly 20% increase in the usage of herbal supplements by the American population.(10) Traditionally, the most popular selling herbs in the United States have been ginkgo biloba, St. John’s wort, ginseng, garlic, Echinacea, saw palmetto, and kava. (11) While the number of clinical trials evaluating herbal supplements has increased along with the growth in the industry, there is still a general lack of scientific evidence supporting the effectiveness and safety of using them. (10, 11)

For example, herbal supplements derived from the native North American plant species Echinacea contain active ingredients that are believed to be immune-enhancing via greater stimulation of macrophagic cytokine production, phagocytic activity, and cell-mediated immunity. Therefore, consumers often are inclined to take echinacea to ward-off or treat colds and upper respiratory infections. No significant side-effects of using this herb have been reported, however, it may trigger allergic reactions in certain individuals, and its use by the immunocompromised is contraindicated.(11) Meanwhile, after performing a meta-analysis of past research studies pertaining to the herb, Gropper et al. concluded that while the results related to the efficacy of echinacea were promising, no conclusive evidence existed. In addition, according to NCCAM's official website, the herb is absolutely ineffective in prevention of colds and respiratory infections.(12) Hence, the usage of echinacea for immunity stimulation appears to be safe for most, however, its efficacy still has not been proven.

Next, ginseng has been used in Asia for therapeutic purposes for centuries, and is presently very popular in the United States. Consumers partake of ginseng as an herbal remedy to "increase the body's ability to resist or cope with stress", "help the body build vitality", and fight cancer.(11) However, the majority of research studies and meta-analyses concerning the efficacy of the herb have demonstrated that no positive effects of ginseng on the activities of the central nervous system, or as an antioxidant have been established. Even further, quality issues commonly arise with the sale of ginseng products.(11) Often times, products contain very little to no ginseng, in contrast to the information provided by product-labeling. Also, commonly reported side effects of ginseng use include headache, nausea, diarrhea, insomnia, and nervousness.(11) Therefore, it would seem that some consumers may be purchasing de-

vitalization with their hard-earned dollars as opposed to the increased stamina and vitality they have been promised by internet and magazine ads. In addition, when considering the finding that 70% of patients taking herbal supplements do not tell their physician, the fact that ginseng may negatively interact with the popular anticoagulant warfarin and promote diuretic-resistance is alarming.(10)

Finally, the deciduous, long-living ginkgo biloba tree contains active ingredients identified as having the ability to increase arterial and venous blood flow, especially in terms of peripheral and cerebral vascular circulation, by inducing peripheral vasodilation, reducing the aggregation of red blood cells, and decreasing platelet activating factor.(11) Consequently, the extracts produced by manufacturing the leaves of the native Chinese tree are used for poor circulation problems, as well as neurosensory issues, since the active ingredients it contains also alter neurotransmitter receptors while exhibiting antioxidant properties. Side effects of using the herb include headaches, dizziness, palpitations, and mild gastrointestinal distress including nausea and vomiting. Also it, like ginseng, it has been shown to interact with warfarin.(11) Though, ginkgo bilbo has been shown to have more impact than a placebo in some cognitive, vascular, and cerebral problems, research results have been varied, and further clinical trials are needed to adequately assess the herb's efficacy.(11)

Amino Acid/Performance Enhancing Supplements

Circa 500-400 B.C., athletes and warriors consumed products such as deer liver and lion heart in hopes that this would improve their strength, speed, and even bravery. Presently, elite athletes, "weekend warriors", and amateur fitness fanatics have turned to a vast array of dietary supplements to enhance their physical performance and appearance. This may be

attributed to the notable amount of research which has been conducted in the areas of muscular work, fuel consumption during exercise, and the unique roles of protein, fat, and carbohydrates which was initiated in the early 20th century. Such research has brought the relationship between dietary supplementation and performance enhancement into the spotlight, making it an increasingly popular topic among today's society.(13) Thus, the dietary supplement industry has not surprisingly seized the opportunity to capitalize on the desire of consumers to take a pill in order to increase fitness levels as an alternative to working harder physically which takes time and effort.(1,14)

Currently, Americans spend over a billion dollars each year on ergogenic aids in belief that these supplements will improve their athletic performance, increase their energy levels, or improve their appearance. Unfortunately for them, there have been little to no large, randomized, double-blinded, placebo-controlled studies on any of the performance enhancing supplements that hard-earned money is being exchanged for. Of the wide variety of ergogenic aids available on the market, protein (or amino acid) supplements appear to be the most frequently purchased.(14).

Unlike carbohydrates and fats, proteins primary functions are regulatory and structural in nature as opposed to energy provision. Therefore, proteins are not typically utilized for energy in the body, as long as a negative energy balance is avoided. However, if dietary protein intake is insufficient, the unstable structural proteins found mainly in skeletal muscle will be oxidized, (or degraded), as a source of essential amino acids for the synthesis of proteins such as enzymes and hormones. Currently the USDA's dietary reference intake (DRI) for protein consumption by the general population is 0.8 g/kg bodyweight/day, an amount which is easily

exceeded by the typical American diet. Consequently, it may be assumed that the average American's lean body mass will not be depleted by increased skeletal muscle turnover rates so long as a positive energy balance is maintained.(15)

Regardless of the fact that dietary sources of protein are sufficiently available from the American food supply to meet current recommendations for daily protein intake, both amino acid and whole protein supplementation is growing in popularity. Why? Nosaka argued that consumers may find protein supplementation to their advantage for the following reasons: It provides protein without the time and effort it takes to prepare or cook food; higher levels of protein may be ingested as appetite is not an issue; supplementation of amino acids enables one to increase protein intake without increasing intake of the other nutrients including energy; and absorption of amino acids from supplements occurs at a faster rate than dietary protein.(15) Ultimately, the use of protein supplements is commonly practiced by those seeking increased muscle mass, improved appearance, and athletic performance.(15)

In this era of body-building and ever-growing desires for ways to excel to levels of athletic performance which have never been reached before, our society has become attracted to the idea of taking supplements in belief that this will reduce the amount of muscle damage experienced upon training, decreased the amount of time overworked muscles require to recover, and increase the muscle-synthesizing effects of exercise.(15) While the underlying mechanism is not completely understood, muscle damage may be induced by eccentric (lengthening) exercise, leading to protein breakdown and inflammation accompanied by soreness or pain. Interestingly, however, as Nosaka pointed out, there have been several studies which concluded that the daily protein requirements for athletes are not necessarily

higher than the DRI as long as a positive energy balance is maintained. If an athlete consumes 10-15% of his or her daily calories from protein, acquiring adequate protein from dietary sources should not be a problem.(15)

According to Gleeson, the consumption of high protein diets and protein supplements in order to optimize athletic performance has been partly justified by the fact that 40% of the protein contained within the human body is located within muscle.(16) Additionally, both the structural and enzymatic proteins of muscle tissue are altered by exercise and 25-35% of all the body's protein turnover is carried out in muscles. Consequently, athletes or other individuals trying to achieve an increase in muscle size are attracted to protein hydrolysates, or mixtures of essential amino acids, which offer quicker absorption and delivery of amino acids to muscle than the whole proteins found in food.(16) Indeed, while consumers take supplements in hopes to increase protein synthesis rates and muscle mass, as well as decrease the amount of recovery time required by muscles following exercise, it has not been established that consuming protein supplements practically accomplishes any of these notions. Coincidentally, in 2007, after performing a meta-analysis concerning research studies involving amino acid supplementation and muscle regeneration, Nosaka concluded that while some studies have reported that muscle damage was reduced by amino acid supplementation either before, during, or after exercise, such studies used only indirect markers of muscle breakdown, and the amount of scientific evidence to support the benefits of protein supplementation is limited.(15,16) Despite the weak evidence supporting protein supplementation, this practice remains very appealing to athletes and other fitness-orientated individuals, and the aggressive marketing of such supplements serves to reinforce the hopes of those consumers.

Vitamin and Mineral Supplements

It is well known that adequate amounts of vitamins and minerals are required to support and maintain good health. Deficiencies of these micronutrients can lead to an array of serious and life-threatening complications such as poor bone health, neurological problems, metabolic dysfunction, free-radical damage, blindness, and inadequate coagulation just to name a few.(17) Hence, it is no surprise that multivitamin supplements with or without minerals are the most popular type of dietary supplement in the United States.(18) While there are many arguments presented to consumers about why they should take supplemental vitamins and minerals, there are also many arguments why such a practice may not be the safest or most cost- effective way to acquire their nutrients.

Rolfes S. and Whitney E. declared that “vitamin –mineral supplements may be appropriate in some circumstances.”(19) Individuals having existing nutrient deficiencies, a consistently low energy intake (below 1200 kilocalories), experiencing serious illness, injury, or disease, having increased energy and nutrient needs due to conditions such as pregnancy, lactation, or menstruation, experiencing a medical condition inhibiting the absorption or intake of specific nutrients, or who are not consuming animal products are examples of situations where vitamin and mineral supplementation may be required to support life-sustaining processes.(19) Indeed, vitamin and mineral supplements are regularly recommended by healthcare professionals to ensure nutritional adequacy if circumstances render patients or clients unable to obtain adequate nutrients from foods. This may provide the general, healthy population with a false sense of security and justification for taking such supplements. Unfortunately, as Rolfes and Whitney also highlighted, there are many invalid reasons why

consumers decide to take vitamin and mineral supplements. Therefore, many misleading claims on market are able to coax consumers to part with their billions of dollars annually.(19)

Today, consumers take vitamin and mineral supplements for a wide-variety of reasons, including the beliefs that by doing so they will experience higher energy levels, enhanced athletic performance or physical appearance, increased ability to cope with stress, and/or that taking supplements will “prevent treat, or cure conditions from the common cold to cancer.”(19) All of these beliefs listed are not clinically proven, and are the results of harmful and potentially life-threatening misinformation which creates false perceptions.(19)

For example, in some instances, individuals may delay seeking medical help secondary to the belief that specific vitamin and mineral supplements will effectively relieve their illness. Such beliefs may be incited by the often misleading health and structural-function claims which are included on supplement labels and advertisements. While supplement manufacturers are not permitted to claim that their products may treat specific diseases, they may do so for more common health problems such as memory loss or menstrual cramps. All health claims must be approved by the FDA and be supported by valid scientific evidence.(19) On the other hand, structure-function label claims, or claims “about the role a nutrient plays in the body, how the nutrient performs its function, and how consuming the nutrient is associated with general well-being” are not required to have FDA approval.(19) Instead, structure-function claims must be accompanied by the FDA disclaimer which is as follows: “This statement has not been evaluated by the Food and Drug Administration. This product is not intended to diagnose, treat, cure, or prevent any disease. ” (4) Together, health and structure-function claims entice the desires of consumers with the prospect of a solution for their health problems that does

not involve seeking the help of healthcare professionals; this may lead to potentially dangerous situations, not only due to the avoidance of proper care, but also secondary to an increased risk for nutrient toxicity.(19)

While living beings require certain amounts of vitamins and minerals to stay healthy and strong, excessive amounts of these micronutrients can become extremely harmful or deadly. This is why the U.S. Food and Nutrition Board established tolerable upper intake levels (UL) for each vitamin and mineral. The UL represents the highest daily intake of a nutrient that is likely to pose no risk of adverse health effects to almost all individuals in the general population.(19) In light of the growing popularity and production of functional foods coupled with the high availability of food products in general, surveys have shown that the typical American diet surpasses the Recommended Daily Allowances (RDA) set for the majority of vitamins and minerals.(19)

So why do we as consumers of this nation need to supplement our diet with pills, liquids, or powders? Even further, the nutrient claim, or label claim which indicate what the nutritional content of a supplement, does not always reflect the amount of vitamins and minerals supplements actual contain, while the daily values are not always based on current recommendations. Examples of complications associated with nutrient toxicities include soft tissue calcification, liver damage, impaired glucose tolerance, nerve degeneration, skin lesions, reduced bone mineral density, birth defects, diarrhea, and muscular weakness.(19) In many instances, such as with magnesium and sulfur, toxicity is only possible with the form of the nutrient acquired from supplements. As surveys have indicated that those who take multivitamin and mineral supplements are generally in good health, it appears that the risk for

toxicity and wasted income increases with supplementation of vitamins and minerals.(20) In addition, the bioavailability of vitamins and minerals from supplements is different than those found in food.(19)

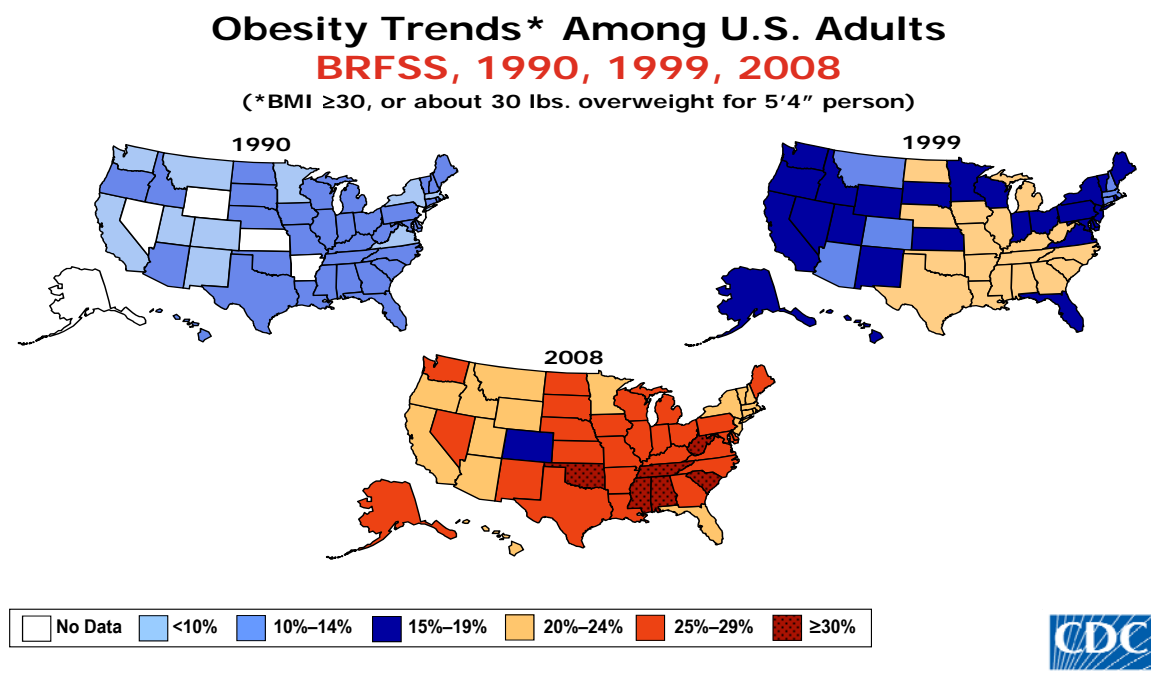
Generally, the human body is able to absorb nutrients from food much better than nutrients presented in their pure, concentrated form--- such as those found in supplements. Nutrients provided from the latter source are likely to interfere with the absorption and/or metabolism of others consumed simultaneously.(19) For example, the supplementation of beta-carotene, a precursor to vitamin A, has been identified to antagonize the metabolism of vitamin E, an important antioxidant in the body.(11) This may help to explain the increase in lung cancer rates found in smokers who took beta-carotene supplements in one study. (19)

Interestingly, while it has been established that the best way to optimize the benefits of vitamins and minerals while avoiding toxicity is by consuming a variety of normal, nutrient-dense foods, the consumers of this nation are obtaining a large percentage of their nutrients from supplements.(19) While there appears to be many justifiable reasons for this, the majority of such reasons are invalid, and the cost-effectiveness and safety of vitamin and mineral supplementation is highly questionable in many circumstances.(19)

Weight Loss Supplements

In 1990, the Center for Disease Control's (CDC) Behavioral Risk Factor Surveillance System (BRFSS) indicated that not one state in the United States of America had a prevalence of obesity equal to or greater than 15%, but only 10 had a prevalence of obesity less than 10%. Almost a decade later, the 1999 BRFSS survey showed that no state was left which had a prevalence of obesity less than 10%, while 18 states had obesity prevalence rates between 20-

24%. In 2008, Colorado was the sole state having a obesity prevalence rate below 20% and it was found that at least one-quarter of each of the populations of thirty-two states were obese. This rapid increase in the prevalence of obesity in the United States is depicted by the CDC famous maps (shown in figure 1) and offers at least some explanation as to why Americans have been spending over \$30 billion dollars annually on weight loss products, including diet pills or weight loss supplements.(3)



Source: CDC Behavioral Risk Factor Surveillance System.

Figure 1

Weight loss supplements are abundant in the U.S. and may be herbal, protein-based, vitamin, or mineral products containing just one or multiple types of ingredients.(21) Such products appeal to the desire of consumers for a quick, simple fix to their weight problems that is easily accessible without a prescription or gym membership. Tempting promises related to weight loss supplements are often explained by one or more of the following mechanisms: Increased energy expenditure, carbohydrate metabolism alteration, increased satiety level, and

modulated fat metabolism. While these purported mechanisms would appear to be effective in inducing weight loss, there is little scientific evidence backing the claims made by the weight loss supplement industry concerning the effectiveness and safety of its supplements.(21,22)

First of all, supplements touted for increasing energy expenditure include products like ephedra alkaloids and caffeine compounds. While such products appear to be effective, they are estimated to be associated with a 2.2-3.6-fold increase in the odds of experiencing adverse psychiatric, autonomic, cardiovascular, and gastrointestinal effects. Interestingly, in 2001, ephedra products represented only a fraction of dietary supplement sales, but were identified as being responsible for 64% of all herb-related adverse events reported to U.S. Poison Control Centers.(21) As noted previously, ephedra was banned by the FDA in 2004; however, several ephedra-containing products remain on the market, as evidenced by a simple Google search.

Next, another mechanism by which weight loss supplements are purported to help one achieve weight loss is altered carbohydrate metabolism. For example, chromium picollinate supplements are marketed under this category since hyperglycemia, hyperinsulinemia, hypertriglyceridemia, and low levels of high-density lipoprotein have been associated with chromium deficiency. The existing theory is that chromium levels may influence body composition. However, the placebo and treatment groups of a few small randomized control trials showed no differences in weight loss. Also, the form of chromium contained in such supplements potentially could reap free-radical damage on the body. Another testament to the fact that the efficacy and safety of weight loss supplements are not established.(21)

Even further, supplements purported to increase satiety such as guar gum and glucomannan appear to be safe but show little to no efficacy. Meanwhile, supplements such

as hydroxyycitric acid that are promoted to increase fat oxidation or decrease fat synthesis are typically well-tolerated. However evidence concerning the effectiveness of such supplements is mixed.(21)

It appears that weight loss supplements are no exception to the de-regulated dietary supplement industry. Unfortunately, however, consumers still continue to ignorantly purchase supplements believing they are safe and effective and that the advertisements for them are genuine. While the safety of supplements is an obvious issue, the efficacy of “diet pills” also may send consumers into a viscous cycle of failure to lose weight followed by lack of motivation to try again; lacking success at previous weight loss attempts has been identified as a factor associated with not trying to lose weight.(22) Considering the prevalence of obesity and overweight in this country, this may be viewed as a serious issue.

Dietary Supplementation and the College Population

The transition from high school to college is typically accompanied by drastic changes in numerous aspects of life including surrounding environment, financial status, social situations, and overall independence level just to name a few.(23) Consequently, it is not surprising that young adults entering college begin to engage in experimentation and exploration as they attempt to cope with such transitions while shaping their futures. Furthermore, many studies have linked moving away to college as a stage of change to the development of unhealthy behaviors such smoking and drinking, decreased physical activity, and diminished diet quality.(23) These behaviors are deemed as the likely foundation of the infamous “freshman fifteen.” In addition, college students dealing with the demands of a job, seemingly endless hours of class and studying, developing a new social-life and possibly family life, and acquiring a

completely new lifestyle, (which apparently is going to make them fat), often experience high levels of anxiety and depression.(24) In the 2005 American College Health Associate National College Health Assessment Survey, 13.4% of students reported anxiety, 19.6% reported depression, while 80.7% and 93.8% reported sadness and a sense of being overwhelmed respectively. Even further, our society in general appears to be leaning toward self-care with complementary and alternative medicines.(25) This trend, in conjunction with the fear and occurrence of the “freshmen fifteen”, poor lifestyle development, and emotional distress leaves college students who are already innately open to experimentation and expansion, vulnerable to food and nutrition misinformation. Consequently, the college population may be especially receptive of unsafe, inefficient dietary supplementation.(23,24)

To date, only a few studies have been conducted focusing on the dietary supplementation practices of college students. Generally, those studies have indicated that the rate of dietary supplementation in the college population is higher than that of the general population with the most frequently used products being vitamin and mineral supplements, and the nonvitamin and mineral supplements such as echinacea, ginseng, St. Johns wort, ginkgo biloba, ephedra products (in 2001), chamomile, and garlic.(24,25) Stasio et al. found that 70.6% of the 201 student sample-size of their study reported using an herb or dietary supplement in the week before they took the survey.(24) Of the supplement users, 31.3% were taking herbal supplements, 16.4% were taking performance enhancing products, 59.7% were taking vitamins and mineral supplements, and 14.4% were using weight loss supplements. These results reflect a trend toward self-medication and pharmacotherapy specifically among U.S. college students. In addition, only 12% of the study participants were over the age of 24; meanwhile,

dietary supplementation has been found to increase with age.(24) Therefore, it might be expected that a sample of older classmen might have even higher usage rates.

Additionally, Ambrose and Samuels found that of the 1,754 students at Rutgers University surveyed in 2004, 51% reported the use of herbal supplements; relief of physical symptoms, the prevention of illness, and general well-being were the primary reasons reported for using such products, especially echinacea, ginseng, St. John's Wort. Chamomile, and ginkgo biloba.(25) Similarly, of the 272 Washington state students who responded to their survey, Newberry et al. found that 48.5% took a dietary supplement in the 12 months preceding the survey, with the most frequently used products and reasons for taking the supplements corresponding with those of the students and Rutgers University.(25) Furthermore, Perkin et al surveyed 1,000 students attending a mid-sized urban university. The results were that 26.3% of the sample was using supplements, and ginseng, echinacea, and protein supplements were the most frequently used supplements.(25) Interestingly, none of these studies indicated that there was a difference between supplement users and non-users in terms of sex, ethnicity, self-perceived health and dietary status, or athletic status. These studies also represent the limited amount of existing scientific data related to the use of dietary supplementation.

Furthermore, other studies focusing on the usage of dietary supplementation throughout the adolescent population, such as a survey conducted by the Blue Cross/Blue Shield Association's Healthy Competition Foundation which found that 1 in 5 American youths knows a peer who is taking such supplements either to improve physical appearance or enhance athletic performance, may also provide researchers with an estimate of the patterns of dietary supplements use by younger college students.(26) Regardless, there still remains

much more room as well as justified reasons for further investigation into the matter of dietary supplementation in the college population. No identified past studies have been conducted evaluating the relationship between dietary supplementation and dietary habits, or the efficacy and safety of the dosages taken by college student supplement users. Such information is what the following study aimed to obtain as it would help magnify whether or not dietary supplementation represents a specific source of food and nutrition misinformation hindering the development of healthy dietary habits during a stage of change which renders individuals prone to experimentation and exploration.

An Investigation of Dietary Supplementation as a Potential Source of Nutrition

Misinformation Hindering the Development of Healthy Eating Habits in College Students

At this point, it has been established that food and nutrition misinformation is on the rise, the dietary supplement industry remains deregulated, and college represents a stressful stage of change that is associated with high levels of individual experimentation and exploration. Meanwhile, examples of commonly reported reasons for the usage of dietary supplements include achieving weight loss, enhancing physical appearance, ensuring adequate nutrient intake when high quality food consumption is low, as well as boosting energy levels. This information serves as evidence that college students may be especially vulnerable to the marketing ploys of so-called “magic bullets” and other supplements that are purported to help one cope with the high demands and transitional experiences of college-life.

Overall, it appears that the concept of *supplementing* the diet has morphed into the issue of *replacing*, *inflating* the price, or *gambling* with the safety of one’s diet while disregarding the basic principles of healthful eating supported by qualified nutritional professionals. Consequently, the purpose of this investigation is to assess the degree to which dietary supplementation may be considered a source of food and nutrition misinformation antagonizing the development of healthy eating habits of students at Utah State University (USU). As no identified past studies have approached the issue of dietary supplementation from this standpoint, it is difficult to predict how the usage of dietary supplements will directly and indirectly affect the dietary habits of college students, however it seems reasonable to assume that the dietary supplement users will exhibit differing eating habits than non-users.

Methodology

In order to comprehend the current trends in dietary supplementation practices throughout USU's student population, as well as to compare the dietary habits of supplement users and nonusers, questions probing students to identify the following information about their supplementation practices were included in a survey also containing a modified version of the Youth and Adolescent Questionnaire (YAQ) food frequency questionnaire: The names of dietary supplements currently being used; the reasons and sources of information encouraging such supplementation; and the nature of the students' supplementation practices (i.e. the frequency and duration of supplementation). The survey was made available electronically via Blackboard to 1300 USU freshmen students during the fall semester of 2009. Data generated from the survey was statistically analyzed using SPSS software.

Results and Discussion

Demographics

As indicated in Table 1, of the 512 students who completed the survey, 68% were female, 93% were between the ages of 18- and 19-years old, and 94% were Caucasian. Meanwhile, most of the students were concerned about making healthy food choices. Consequently, minority groups were not adequately represented in this study, and the sample population was representative of the standard college freshman in terms of age.

Table 1

Survey Results	
Number	512
Female	349 (68.2%)
Male	163 (31.8%)
Non-Hispanic white	484 (94.10%)
Native Hawaiian or other Pacific Islander	3 (<1%)

Other ethnicity	25 (<5%)
Mean age (years)	18.22
USU athlete	101 (21%)
Concern about making healthy food choices	454 (88.7%)

Prevalence of Dietary Supplementation

Out of the survey population, 27% reported taking a multivitamin and mineral supplement and 20% reported the use of other supplements such herbal, protein, weight loss, and single nutrient supplements (see summary in Table 2). Of those taking a multivitamin, the majority (49%) reported beginning to take the supplement within the past two years, and most (32%) took 3 to 5 dosages a week. Of those taking another type of supplement, the majority (63%) reported initiating such supplementation practices within the past 2 years, and 38% were taking such supplements 3 to 5 times a week. These descriptive statistics indicate that adolescents 18- to 19- years of age may be particularly prone to initiating supplementation prior to or as attending their first year of college.

Summary of “Other” Supplements Used

While the most commonly reported supplement taken by the supplement users was a multivitamin, Table 2 contains a summary of names of other types supplements users reported taking.

Table 2

Single or Specific Nutrient Combination		
Calcium Plus with magnesium and vitamin D	Goldinex Iron Tablets	Fish oil
Calcium pills	Gentle Iron	Fisol
Fiber pills and calcium	Foltrin	Conjugated linoleic acid
Tums	Spring valley A&D	Lipoic acid
Generic vitamin C	Vitamin D3	
Emergen-C	Vitamin B	

GNC chewable C100	Vitamin C
Member's Mark vitamin C	Vitamin E
Femcon	Zinc
Ferralet 90	
Protein/Performance Enhancer	
Six Star Protein	L-lysine
Amplified Wheybolic	Body builder iron
Extreme 60	Monster milk
Agel products	Optimum Nutrition soy protein
Biophase	Generic protein drink
Body Fortress Whey Protein	GNC whey protein
Creatine	Generic whey protein
EAS Premium Protein	
GNC protein Shake	
Weight Loss	Herbal
ErgoLean AMP	Echinacea
Generic diet pills	Super GLA
Medifast meal replacement	

As is made evident in the table above, aside from multivitamins, single nutrient supplements, including protein supplements, were the most popular types of supplements taken by the survey population. This is consistent with the results of other similar studies. Furthermore, the types of supplements being were not notably dangerous; however, the dosages were not identified.

Justification for Supplementation and Sources of Supplement Information

As depicted in Figure 2, the most common reported reasons for taking dietary supplements were related to health or performance enhancement, which is similar to the results of previously conducted studies. Additionally, family members were the most frequently cited source of supplement information, while, interestingly, other medical

professionals (such as Registered Dietitians) were the least frequently cited sources and the media was cited much less frequently as a source of information than previous studies.

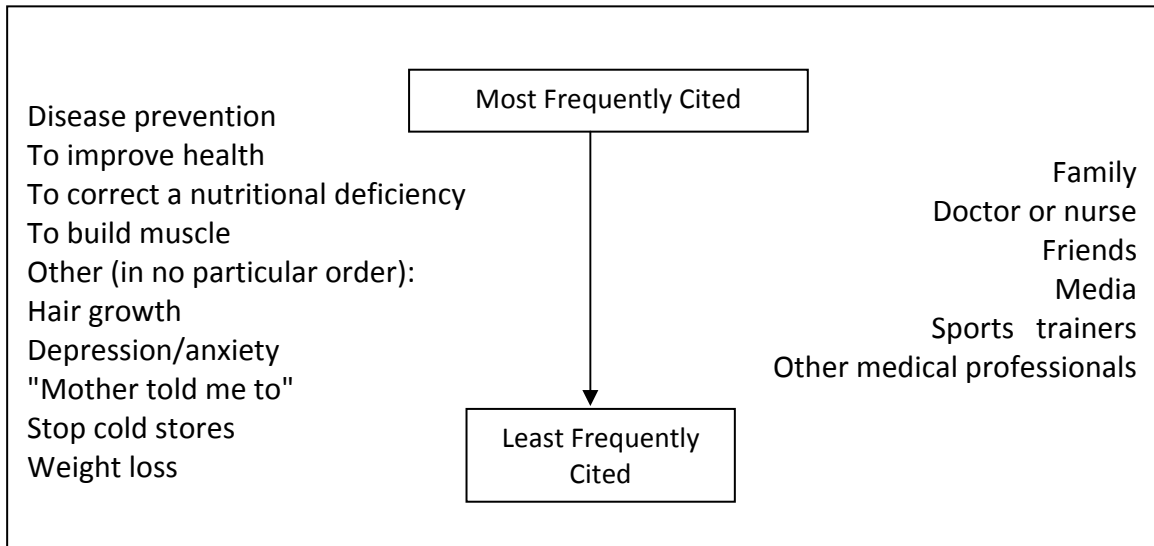


Figure 2

Dietary Patterns of Supplement Users vs. Non-users

No statistically significant (p-value <.05) difference existed between the dietary intakes of supplement users and non-users when compared by the following average nutrient indices: total caloric intake; intake calories from total fat, saturated fat, and trans fat; grams of carbohydrate and protein; micrograms of vitamin D; and milligrams of calcium, iron, and sodium. Fiber intake, however, did differ significantly, with the users achieving a higher intake on average. The similarity between the dietary patterns of supplement users and non-users was surprising and indicates that the practice dietary supplementation may in fact not be influencing the dietary patterns of USU freshmen.

Nutrient-specific Dietary Intakes of Supplement Users

When the average dietary protein intake of protein supplement users was isolated, it was higher than the Recommended Daily Allowance (RDA) for both males and females between

the ages of 19-30 years of age. The same went for the calcium intake of calcium-supplement users. This indicates that the cost-effectiveness of such supplementation practices may be low. In contrast, the average iron intake of iron supplement users was lower than the RDA for iron intake of both males and females between the ages of 19- and 30-years. This was attributed to the fact that many of the study's participants reported that they were taking supplements to correct iron deficiency anemia.

Conclusion

From this study, it can be determined that dietary supplementation does not represent a source of nutrition misinformation hindering the development of healthy eating habits in college students. However, it was identified that very few of the supplement users received information to take supplements from an accredited nutrition professional, with the majority receiving information from family members. This, in conjunction with the de-regulated state of the dietary supplement industry, the finding that those freshmen taking specific nutrient supplements (i.e. protein and calcium) are already receiving adequate amounts of the supplemented nutrient through dietary intake, and the current prevalence of on-campus dietary supplementation leads to the conclusion that on-campus nutrition professionals should play an active role in providing information to students concerning the potential risks and benefits of dietary supplementation. Such action would be in accordance to the American Dietetic Association's position that "the expertise of dietetics practitioners is needed to help educate consumers on the safe and appropriate selection and use of nutrient supplements to optimize health. Dietetics practitioners should position themselves as the first source of information on nutrient supplementation." (27) Lastly, this study was limited to freshmen

mostly 18- to 19- years-of-age, did not provide an adequate representation of minority groups, and like previous similar studies, involved mostly female participants. Hence, more research is needed to evaluate the impact of dietary supplementation on the entire college population.

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Author Autobiography

Mary Anne Dimmick, raised in Sandy, Utah, graduated from Alta High School in 2006, the same year she entered Utah State University as a Presidential scholar majoring in Mechanical Engineering with an aerospace emphasis. After enrolling in Professor Janet B. Anderson's NFS 1020 course her first semester, however, Mary's mind for calculus and rocket ships was entranced by chemistry and nutrients. Her lifelong passions for healthy-living took over, and she wasted no time to switch her major to Nutrition, Dietetic and Food Sciences with a dietetic emphasis. During her first two years as an Aggie, Mary enhanced her college experience by joining the Dietetics Club, spending one semester on the Institute Party-planning Committee, and becoming an Aggie Village Area Council President along with her husband. Meanwhile, she was able to keep her grades up enough to receive USU's A-pin award. In addition, she acquired dietetics experience by working in the kitchen of a skilled-nursing and rehabilitation facility as both a dietary aide and night cook. After being accepted to the demanding and time-intensive coordinated dietetics program (CPD) her junior year, Mary decided to focus mostly on her schoolwork, but was able to capitalize on the opportunity to become a NDFS tutor and academic mentor for USU's Student Athlete Services. Furthermore, during the summer preceding her senior year, Mary assisted the esteemed NDFS professor Dr. Heidi Wengreen and Katie brown, a brilliant NDFS graduate student, in developing and teaching the curriculum of the Healthy Eating section for USU Connections week of the fall 2009 semester. During her final year as an undergraduate student, Mary completed a 1000+ hour clinical- and community-based dietetics internship in addition to her regular studies as required by the CPD program.

After she graduates in May 2010, Mary plans to become certified as a Registered Dietitian as well as a personal trainer, and then continue her studies at Utah State University as a graduate student beginning the fall semester of 2010. She plans to obtain her Master's degree from the Nutrition, Dietetic and Food Sciences department, and hopes to conduct meaningful research concerning either the eating trends and habits of college students, or, possibly, the role of nutrigenomics in the treatment of debilitating diseases such as gastroesophageal reflux disease and multiple sclerosis. Go Aggies!