The Impact of a Food Elimination Diet on Collegiate Athletes' 300-meter Run Time and Concentration

排除饮食法对大学生运动员跑 300 米所需时间和注意力的影响

Impacto de una dieta de eliminación de alimentos en el tiempo y concentración en la carrera de 300 metros de los atletas universitarios

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ABSTRACT

Background: Optimal human function and performance through diet strategies are critical for everyone but especially for those involved in collegiate or professional athletics. Currently, individualized medicine (IM) is emerging as a more efficacious approach to health with emphasis on personalized diet strategies for the public and is common practice for elite athletes. One method for directing patient-specific foods in the diet, while concomitantly impacting physical performance, may be via IgG food sensitivity and *Candida albicans* analysis from dried blood spot (DBS) collections.

Methods: The authors designed a quasi-experimental, nonrandomized, pilot study without a control group. Twenty-three participants, 15 female, 8 male, from soccer/volleyball and football athletic teams, respectively, mean age 19.64+0.86 years, were recruited for the study, which examined preposttest 300-meter run times and questionnaire responses after a 14-day IgG DBS–directed food elimination diet based on IgG reactivity to 93 foods. DBS specimen collection, 300-meter run times, and Learning Difficulties Assessment (LDA) questionnaires were collected at the participants' university athletics building on campus. IgG, *C albicans*, and *S cerevisiae* analyses were conducted at the Great Plains Laboratory, Lenexa, Kansas.

Results: Data indicated a change in 300-meter run time but not of statistical significance (run time baseline mean=50.41 sec, run time intervention mean=50.14 sec). Descriptive statistics for frequency of responses and *chi*-square analysis revealed that 4 of the 23 items selected from the LDA (Listening-Memory and Concentration subscale R=.8669; Listening-Information Processing subscale R=.8517; and General Concentration and Memory subscale R=.9019) were improved posttest.

Conclusion: The study results did not indicate merit in eliminating foods based on IgG reactivity for affecting athletic performance (faster 300-meter run time) but did reveal potential for affecting academic qualities of listening, information processing, concentration, and memory. Further studies are warranted evaluating IgG-directed food elimination diets for improving run time, concentration, and memory among college athletes as well as among other populations.

摘要

背景：通过饮食策略达到最佳的人体机能和性能对每个人都十分重要，对大学或专业运动员尤为关键。目前，强调个人化饮食策略的个体化用药 （individualized medicine, IM) 正在成为更有效的大众保健方法，更是精英运动员的常见做法。通过采集干血点 (dried blood spot, DBS) 进行 IgG 食物敏感性和白色念珠菌分析，可能是针对个体患者指导饮食中食物的选择，同时影响体能表现的一种方法。

方法：我们设计了一项无对照组的准实验、非随机前导性研究。分别从足球/排球和足球运动队中招募了 23 名参与者作为研究对象，包括 15 名女性，8 名男性，平均年龄为 19.64+0.86 岁；基于 IgG 对 93 种食物的反应，让参与者接受了 14 天的 IgG DBS 导向排除饮食法，并在试验前后，分别测试了跑 300 米所需时间以及进行问卷调查。DBS 采样、跑 300 米所需时间测试以及学习困难评估 （Learning Difficulties Assessment, LDA) 问卷调查在参与者的校内运动场馆中进行。IgG、白色念珠菌 （C albicans) 和酿酒酵母分析 （S cerevisiae analyses) 在堪萨斯州雷列涅萨市大平原实验室进行。

结果：数据表明跑 300 米所需时间有变化，但无显著性统计差异（基线平均跑步时间=50.41 秒，干预后平均跑步时间=50.14 秒）。回答频率和卡方分析的描述性统计显示，LDA 问卷（听力-记忆力和注意力分量表 R=0.8669；听力-信息处理分量表 R=0.8517；一般注意力和记忆力分量表 R=0.9019）的 23 个项目中，有 4 项在试验后有改善。

结论：研究结果显示，基于 IgG 反应排除某些食物，并没有改善运动表现（即缩短跑 300 米所需时间），但有可能影响听力、信息处理、注意力和记忆力等方面的学习能力。需要进行进一步研究以评估 IgG 导向排除饮食法对改善大学生运动员以及其他人群的跑步时间、注意力和记忆力的影响。

RESUMEN

Antecedentes: la función y rendimiento humano óptimos a través de estrategias dietéticas son críticos para todo el mundo, pero en especial para aquellos que practican el atletismo universitario o profesional. En la actualidad, la medicina individualizada (MI) está emergiendo con un enfoque más eficaz para la salud, que hace hincapié en las estrategias dietéticas personalizadas para el público en general y es una práctica frecuente entre los atletas de élite. Se trata de un método que apunta a los alimentos específicos para cada paciente en la dieta y, al mismo tiempo,

influye en el rendimiento físico. Este se puede obtener mediante la prueba de la IgG para la sensibilidad a los alimentos con candida albicans a partir de gotas de sangre seca (DBS, por sus siglas en inglés).

Métodos: los autores diseñaron un estudio preliminar cuasiexperimental, no aleatorizado, sin grupo control. Para este estudio, se reclutó a veintitrés participantes: 15 mujeres y 8 hombres, de equipos atléticos de fútbol/voleibol y fútbol americano respectivamente, con un promedio de edad de 19,64 + 0,86 años. El estudio examinó los tiempos antes y después de las carreras de 300 metros y las respuestas a los cuestionarios tras una dieta de eliminación de alimentos mediante la prueba DBS de la IgG de 14 días, basada en la reactividad de la IgG a 93 alimentos. La recogida de muestras DBS, los tiempos de la carrera de 300 metros y los cuestionarios de valoración de las dificultades de aprendizaje (LDA, por sus siglas en inglés) se obtuvieron en el departamento de atletismo de la universidad de los participantes en el campus. Los análisis de IgG, C albicans, y S cerevisiae se realizaron en Great Plains Laboratory, Lenexa, Kansas.

Resultados: los datos indicaron un cambio en el tiempo de la carrera de 300 metros pero que no era estadísticamente significativo (tiempo medio inicial de la carrera = 50,41 s, tiempo de la carrera tras la participación = 50,14 s). Las estadísticas descriptivas para la frecuencia de las respuestas y el análisis de chi cuadrado revelaron que 4 de los 23 elementos seleccionados del cuestionario LDA (subescala escucha-memoria y concentración, R = 0,8669; subescala procesado escucha-información, R = 0,8517; y subescala general de concentración y subescala de memoria, R = 0,9019) mejoraron tras la prueba.

Conclusión: los resultados del estudio no indicaron utilidad alguna en cuanto a eliminar las comidas, basándose en la reactividad a la IgG a la hora de afectar el rendimiento atlético (menor tiempo de carrera de 300 metros). Sin embargo, sí revelaron una capacidad potencial que influye en las capacidades académicas, como la de escuchar, procesar información, la concentración y la memoria. Se necesitan otros estudios para evaluar las dietas de eliminación de alimentos dirigidas por la IgG para mejorar el tiempo de la carrera, la concentración y la memoria entre atletas universitarios así como en otras poblaciones.

INTRODUCTION

Chronic subacute inflammation is linked to an increasing number of illnesses and health detriments.[1] Contributing factors for the etiology of inflammation and its pathologic sequelae are ubiquitous. Environmental toxins, such as industrial chemicals in air, food, water, clothing, home and building materials, crowded living conditions, excessive noise and electromagnetic stress, and mold, are representative. Another factor for the inflammatory response may be the type of food consumed. Studies are examining the concept of food sensitivity and the underlying mechanisms by which the inflammatory response is elicited in health and disease states.[2-3] Among the plethora of diet plans available to the public, few if any provide an individualized, quantitative analysis of food sensitivity to guide food selection based on immunoglobulin G (IgG) reaction.[4-6] Currently, there is media attention to gluten-free (GF) diets, personalized online support–type diets (Dukan), and group support–type diets such as Weight Watchers, Dietary Approaches to Stop Hypertension (DASH), Therapeutic Lifestyle Changes (TLC), the Mayo Clinic diet, and the Mediterranean diet, to name a few.[4] These are gauged on their ability to promote weight loss and prevent diabetes and heart disease and the degree of "balance" they offer as determined by a team of experts.

Although it may be inferred that weight loss alone will result in improved physical performance, possibly due to joint relief, flexibility, or self-confidence changes, none of the 2014 top-ranked US diets was recognized for attributes of improving physical performance or cognitive abilities by removing IgG-reactive foods from the diet for any period of time. A case in point regarding GF diets is Novac Djokovic, number one–ranked singles tennis player, who had the greatest singles tennis season after winning three Grand Slams and remaining undefeated for 43 consecutive matches. Less than a year before his successful season, Djokovic had struggled to complete a full tournament. He suffered from decreased stamina and aches, pains, and breathing difficulties. As his career progressed, he was overcome with fitness crises, sometimes vomiting violently during a match and experiencing the sudden onset of extreme sluggishness and fatigue. An investigation led to the discovery of his strong intolerance to wheat and slight intolerance to tomatoes. His change to a GF diet transformed his health, training, and professional tennis ranking.[7]

Research in the area of the human gut microbiome is revealing a link between the central nervous system (CNS), the stress response, mood, cognition, pain, and obesity. Although the routes of communication between these entities have not been fully elucidated, they involve the neural, humoral, immune, and metabolic pathways.[8-9] Microbe-based therapeutics are discovering an endocrine attribute of the commensal microbiome and using this pathway to explain appetite and satiety, learning and memory, pathogenesis interruption, brain function, and behavior. A laboratory in California is treating autism-speech brain centers in mice with *Bacillus fragilis* and achieving favorable results.[10] The Great Plains Laboratory, Inc (GPL, Lenexa, Kansas) provides testing procedures also looking at the microbiome, metabolic pathways, nutritional status, and allergy testing of human systems via tissue samples primarily of blood and urine.[11]

The IgG Food Allergy Test from GPL identifies sensitivities to 93 foods, including foods commonly eaten as well as several foods that are used as substitutes for com-

mon hypersensitivity trigger foods. This test also detects IgG antibodies to *Candida* (*C albicans* and *S cerevisiae*), common yeast species. *Candida* overgrowth in the gut may contribute to food allergies and sensitivities by allowing absorption of partially digested proteins (peptides). Partially digested proteins can cause an immune response by eliciting tissue invasion. Tissue invasion may be another way of expressing peptides passing into the bloodstream, and since these partial proteins are not recognized as normal in the bloodstream, the body mounts an immune response against them.[12] When individuals have food intolerances, adequate metabolism is impaired, resulting in partially digested substances, particularly proteins, entering the system. The body's reaction to these partially digested substances is similar to any "foreign invader" and initiates the inflammatory response cascade.[13-14] Inflammation in the small intestine disrupts digestive regulation and can lead to fatigue, poor concentration, and other debilitating conditions. Individuals have the potential to increase their perceived energy, concentration, and feelings of optimism or mood by eliminating the foods that are inflammatory triggers to their digestive process.[11]

When evaluating sera/plasma for food sensitivity, there is some debate on the usefulness of IgG vs other members of the immunoglobulin family. Volppi and Maccari found that the enzyme-linked immunosorbent assay (ELISA) test for IgG antibody was a useful indicator for adverse reactions to food and food hypersensitivity.[15-18] The position statement by the Canadian Society of Allergy and Clinical Immunology is concerned about the positive IgG test results that occur in healthy adults and children considering that unnecessary food elimination, decreased quality of life, and expense will be incurred in these individuals based on the inappropriate use of IgG test results. It is known that food-specific IgGs are present in healthy and in symptomatic adults eating certain foods on a regular basis.[17,19,20] The use of IgG antibody reaction to certain foods testing, while under debate, is gaining more favorable results and being reported in the literature.[5,19] One such corporation conducting IgG antibody to food antigen response is GPL. In 2013, GPL processed 9878 food allergy tests in the United States and 4503 tests among 37 other countries. GPL, a research-based clinical laboratory offering testing for nutritional factors in chronic illness worldwide, is currently serving health professionals in more than 100 countries. Founded in 1996, GPL has tested more than 200000 patients with diverse conditions with the goal of facilitating maximum human potential through quality laboratory testing. This research was conducted in cooperation with and with support from GPL and the University of Central Missouri (UCM) due in part to this rich history, humanitarian philosophy, and technical ability, characteristics that are not typical of other laboratories. Considering these issues, this study used IgG antibody reaction to 93 food antigens plus yeast (*C albicans* and *S cerevisiae*) from DBS specimens to design an individualized food elimination diet for college athletes.

The participants were also tested for their speed on a 300-meter run and on their views about their learning as gauged by responses on the Learning Difficulties Assessment (LDA) questionnaire[21] at baseline and after the 14-day food elimination trial to determine if run time and cognition were improved.

METHODS

Participants

The current pilot study was approved by the UCM Institutional Review Board in March 2014. All interventions were conducted on campus property while the DBS specimens were mailed to GPL for IgG analysis using its robotic system for food sensitivity evaluation. The university's assistant athletic director was contacted to determine the feasibility of the study. Collaboration between the athletic department and the researchers yielded 3 athletic teams willing to support the research. Eleven soccer players, 4 volleyball players, and 8 football players were invited and consented to participate in the pilot study, with 17 of 23 completing the study baseline (pretest), DBS, intervention (14-day food elimination diet), and posttest measures.

The inclusion criteria for this study were as follows: (1) must be aged 18 years or older, (2) must be a member of a collegiate athletic team, and (3) must be able to run 300 meters. Exclusion criteria included pregnancy. Participants were recruited by their respective coaches and encouraged to participate at their own discretion. Scheduling for obtaining informed consent documents, baseline 300-meter run time, DBS specimens and LDA responses was coordinated by the university's assistant athletic director and the investigators in this study. Participants were informed of the required consultation with the registered dietitian to discuss IgG food sensitivity reports prior to beginning the 14-day food elimination diet.

Intervention

After print and electronic IgG food sensitivity reports were received by the investigators in the study, participants were scheduled to engage in a 20-minute diet consultation to guide food choices while on the 14-day food elimination diet. A sample IgG food sensitivity with *Candida* report, sample food diary forms and participants' food selected during the 14-day food elimination trial, and the LDA are displayed in Appendices A-C. Participants were asked to avoid completely all moderate and highly reactive foods and to be aware of and restrict as much as possible those that were ranked low reactive foods for the trial period. After the 2-week food elimination period, participants were asked to meet in the same place where the initial data collection occurred to repeat the 300-meter run and the LDA survey. There was no surveillance of participants' adherence to the food elimination process, nor was any baseline question asked about other factors that could contribute to elevated *Candida* findings with DBS examination (eg, oral contraceptives, antibiotics,

anti-inflammatory agents, anticancer medications." Participants were not provided with any food by the researchers during the 2-week food-elimination period. Ad hoc surveys were sent electronically to all study participants approximately 4 months after the study to determine if participants continued to engage in the diet changes suggested by the IgG antibody test results. Other follow-up questions were asked about continued feelings of improved athletic ability, improved concentration, ease of following the diet, and whether or not participants were under a physician's care for prescribed medications.

Outcome Measures

The IgG Food Allergy Test measures the relative presence of IgG antibodies to specific food proteins. The serum is introduced to protein extracts from each of the different foods. If food-specific binding occurs between the antigen proteins and the participant's IgG serum antibodies, a symptomatic reaction to that food is possible. IgG antibodies to *Candida* may be due to past infections and thus do not indicate a current infection; however, *Candida* antibodies may trigger autoimmune disease. *Candida* antibodies are elevated in Crohn's disease, cystic fibrosis, and cancer. A wide range of disorders have been linked to *Candida*, including depression, chronic fatigue, thyroid disorders, autism, and multiple sclerosis. Use of antibiotics, oral contraceptives, chemotherapy, and anti-inflammatory steroids greatly increase susceptibility to *Candida*.[11] Overgrowth of *Candida* may also cause a rise in cases of food allergies. The process used for human DBS specimens is the ELISA method. This semi-quantitative report reveals sensitivities in a low, moderate, or high range of reactivity. Subjects were asked to eliminate any moderate or high reactive foods and to restrict those in the low reactivity area for the 14-day food elimination trial.

RESULTS

Data were analyzed using SPSS v 19 (IBM Corp, Armonk, New York) using a paired samples *t*-test for run time and *chi*-square assessment for baseline and post-

Table 1 Mean and Standard Deviation From the Learning Difficulties Assessment

Item	Pretest Mean±SD (n=17)	Posttest Mean±SD (n=17)	Asymp Sig (P≤.05) pretest; posttest
Age	19.65±0.86		
Run time	50.41±6.41	50.14±5.47	$P=.77$
I hear what someone says; I just do not remember what was said[a]	3.29±0.77	3.82±0.73	$P=.33$; $P=.002$
I have a difficult time listening to lectures	2.88±1.22	3.41±1.12	$P=.15$; $P=.07$
Listening in class is hard for me	3.29±1.26	3.76±1.25	$P=.28$; $P=.28$
I find myself getting lost during lectures	3.35±1.17	3.23±1.14	$P=.06$; $P=.35$
Taking notes makes it hard for me to follow a lecture	3.59±1.23	3.88±1.16	$P=.66$; $P=.47$
Several people have told me that I do not remember much of what I am told	3.70± 0.92	4.00±0.87	$P=.18$; $P=.10$
When I listen to someone talk, it is very easy for me to get distracted	3.18±0.95	3.70±1.16	$P=.10$; $P=.56$
I constantly daydream during class lectures	3.12±1.17	3.23±1.20	$P=.42$; $P=.61$
No matter how hard I try, lectures do not make much sense to me	3.88±1.05	4.23±0.66	$P=.22$; $P=.11$
I have trouble understanding spoken directions	3.88±0.93	3.88±0.86	$P=.052$; $P=.12$
I have a hard time understanding what people are saying	4.00±0.87	4.29±0.68	$P=.10$; $P=.16$
Words that sound alike are confusing to me	4.29±0.69	4.59±0.51	$P=.16$; $P=.47$
I need to have directions repeated before I can understand them	3.53±1.28	3.88±1.32	$P=.12$; $P=.045$
I often get confused about what I want to say	3.94±0.97	3.94±0.83	$P=.12$; $P=.043$
It is hard to listen unless I can see the person who is talking	3.76±0.83	3.47±0.94	$P=.10$; $P=.32$
It is hard for me to listen to a lecture and take notes at the same time	3.88±0.99	3.70±1.10	$P=.27$; $P=.89$
I often get tired and lose concentration after 10-20 minutes	3.12±1.27	3.23±0.97	$P=.51$; $P=.045$
It is hard for me to concentrate in class	3.29±1.10	3.35±1.11	$P=.07$; $P=.18$
I often have trouble remembering particular words	4.06±0.97	3.88±0.99	$P=.052$; $P=.27$
I do not retain much of what I read	3.35±1.06	3.41±1.22	$P=.77$; $P=.18$
When trying to read, the least little thing can distract me	2.76±1.20	2.82±1.51	$P=.61$; $P=.61$
Even when I am concentrating I have trouble remembering what I just read	2.94±1.25	3.59±1.06	$P=.71$; $P=.18$
It is difficult for me to read for more than 10-20 minutes	2.82±1.33	3.29±1.16	$P=.42$; $P=.18$

[a] The higher the value, the less likely there is a learning difficulties issue.

intervention differences on scored survey items. Table 1 displays mean and standard deviation values for age, run time, and survey data. Of the 23 athletes who began the study, 17 (11 females, 6 males) completed all required elements. Those who did not complete the study indicated sport injury or family emergencies as the reason. Table 2 provides individual baseline and post-intervention run times as well as the specific foods and ranking

Table 2 Immunoglobulin G, Run Time Baseline and Post Intervention, and Sample Comments (N=17)

Subject no. M=male F=female	Run$_{bline}$ 300 m in sec	Run$_{Intervention}$ 300 m in sec	IgG Food Reactivity				Candida Scale/ Saccharomyces cerevisiae (Baker's or Brewer's Yeast)				Sample Comments
			NS	Low (L)	Mod (M)	High (H)	NS	Low (L)	Mod (M)	High (H)	
3F	59:06	55:06	M-cheese, casein, whey, milk, gliadin L-Candida, beef, yogurt, orange, sesame, corn, chicken, lamb, barley, asparagus, millet, honey				6.29/M-Baker's yeast				I think it (the study) definitely made a difference in my stomach issues
4F	52:45	49:28	L-Candida, cane sugar, barley, hazelnut, egg white, egg yolk, orange, casein, walnut, avocado, sunflower, honey, milk, goat cheese, lima bean, flax, garbanzo bean, coffee, pear, onion, yogurt, grape, sesame, peach M-pecan, carrot, rye, sweet potato, corn, blueberry, rice, pistachio, wheat, cheese, asparagus, soybean, grapefruit, green pepper, millet, whey, apricot, buckwheat, garlic H-gliadin, pinto bean, pineapple, tomato, green bean, eggplant, cabbage, peanut, pumpkin, almond, celery, watermelon, lettuce, lemon, radish, sorghum, broccoli, kidney bean, spinach, potato				3.54/M-Baker's yeast				This study was very difficult for me because I was sensitive to so many things.
5F	58:51	52:95	L-orange, coffee, salmon, egg white, asparagus, honey, turkey, sesame, mozzarella cheese, milk, pinto bean, egg yolk, beef, pineapple, kidney bean, halibut, chicken, coconut, corn, soybean				11.70/H-Baker's yeast, M-Brewers yeast				
6F	54:66	49:30	L-milk, sesame, gliadin, coffee, beef, whey, cheese, peanut, orange, chicken, casein				3.64/L-Baker's yeast				
7M	43:40	46:67	L-garlic, orange, tomato, asparagus, sesame, peanut				4.58/NS				It was a different experience for me to change my diet and focus on what I ate.
8M	52:02	46:29	L-pineapple, corn, yogurt, asparagus, grapefruit, green bean, celery, pinto bean, chicken, soybean, pistachio, honey, almond, kidney bean, grape, coconut, lamb, sunflower, turkey, lemon, lettuce spinach, flax, buckwheat, cod fish, rice, broccoli, halibut, pumpkin, mushroom, salmon, pecan, carrot, apricot, garbanzo bean, hazelnut, pork, blueberry, eggplant, potato, cane sugar M-cashews, goat cheese, tomato, coffee, sorghum, peanut, watermelon, garlic, millet, beef, orange, walnut, rye H-egg white, gliadin, egg yolk, cheese, wheat, casein, milk, barley, whey, sesame, mozzarella cheese				13.96/H-Baker's yeast				I thought the study was interesting and helped my concentration abilities.
9M	39:93	42:37	L-yogurt, mozzarella cheese, celery, sorghum, almond, tomato, pinto bean, grapefruit, goat cheese, potato, rye, garlic, pork, kidney bean, corn, pistachio, millet, green bean, pumpkin, lemon, walnut, beef, soybean, pecan, coconut, pineapple, rice, sweet potato, broccoli, buckwheat, flax, orange, spinach, lettuce, asparagus, carrot, cane sugar, hazelnut, eggplant, apricot M-egg yolk, cashews, barley, cheese, wheat, milk, wheat gluten, casein, coffee, watermelon, whey H-gliadin, sunflower, egg white, peanut, sesame				2.55/M-Baker's yeast				

Table 2 Immunoglobulin G, Run Time Baseline and Post Intervention, and Sample Comments (N=17) (*cont.*)

Subject no. M=male F=female	Run$_{bline}$ 300 in sec	Run$_{Intervention}$ 300 m in sec	IgG Food Reactivity				*Candida* Scale/ *Saccharomyces cerevisiae* (Baker's or Brewer's Yeast)				Sample Comments
			NS	Low (L)	Mod (M)	High (H)	NS	Low (L)	Mod (M)	High (H)	
10M	41:24	40:43	L-sesame, garlic, coffee, orange, watermelon, honey, egg white, beef, rye, pumpkin, egg yolk, asparagus, grapefruit, millet M-wheat gluten, wheat, yogurt, goat cheese H-cheese, whey, casein, gliadin, milk, mozzarella cheese				7.87/H-Baker's yeast, M-Brewers yeast				
11M	43:15	49:01	L-chicken, pineapple, corn, halibut, coffee, honey, millet, grapefruit, lemon, sorghum, turkey, sesame M-orange, asparagus				10.96/NS				
14M	59:87	59:00	L-coffee, egg white, egg yolk, gliadin, sesame, peanut				1.12/NS				
16F	48:11	49:31	L-tomato, cashews, orange, gliadin, sunflower, pineapple, peanut, pinto bean, cheese, kidney bean, spinach, whey, casein, asparagus, milk, yogurt, corn, halibut, chicken, garlic, honey, wheat gluten, millet, pumpkin, watermelon M-sesame				13.34/L-Baker's yeast				
17F	50:76	48:38	L-watermelon, peanut, corn, lemon, garlic, sorghum, pinto bean, chicken, sesame, tomato, millet, lamb, rye, turkey, green bean, casein, lettuce, broccoli, honey, grapefruit, soybean, grape, halibut, coconut, kidney bean, beef, walnut, barley, pork, garbanzo bean, celery, radish, pumpkin, yogurt, potato, carrot M-egg white, wheat, orange, wheat gluten, coffee, milk, asparagus, whey, goat cheese, cheese H-pineapple, gliadin, egg yolk				12.50/M-Baker's yeast				
18F	51:28	56:00	L-asparagus, wheat gluten, pineapple, wheat, egg yolk, garlic, chicken, goat cheese, egg white, casein, honey, corn, sesame, grapefruit, halibut, millet, pork, cheese, soybean, beef, salmon, turkey M-orange, gliadin				9.53/NS				
20F	50:08	51:18	L-garlic, goat cheese, milk, pineapple, pinto bean, oat, peanut walnut, grapefruit, barley, kidney bean, sesame, broccoli, pumpkin, rye, grape, millet, sorghum, green bean, chicken, soybean, mushroom watermelon M-wheat, whey, yogurt H-egg white, casein, cheese, gliadin, mozzarella cheese, egg yolk, wheat gluten				2.13/M-Baker's yeast, L-Brewers yeast				I liked the study; it made me feel much better and I learned a lot.
21F	43:23	47:63	L-orange, asparagus, honey, pumpkin, coffee, apple, sesame M-cheese, casein, yogurt H-whey				8.41/H-Baker's yeast, M-Brewers yeast				
22F	52:21	52:00	L-carrot, watermelon, mozzarella cheese, lettuce, cabbage, celery, asparagus, wheat gluten, pinto bean, apricot, radish, orange, coffee, pumpkin, sorghum, green bean, eggplant, grapefruit, wheat, broccoli, corn, almond, pecan, sesame, potato, cane sugar, spinach, milk, goat cheese, rice, pistachio, rye, sweet potato, walnut, millet, whey, blueberry, peanut, garbanzo bean, avocado, barley, kidney bean, buckwheat, soybean, banana, tuna M-egg yolk, casein, garlic, lemon, tomato, pineapple, cheese H-gliadin, egg white				2.80/L-Baker's yeast				
23F	56:48	60:33	L-milk, egg white, orange, goat cheese, asparagus, egg yolk, chicken, sesame, halibut, gliadin M-mozzarella cheese, whey, yogurt H-cheese, casein				6.82/M-Baker's yeast				

of reactivity based on the nominal scale of Not Significant-NS, Low-L, Moderate-M, or High-H, according to the IgG, *Candida*, and *Saccharomyces* analysis as well as a few randomly selected comments from study participants. Paired samples *t*-test did not reveal a significant difference pre-posttest (t=0.29, df=16, P=.77). *Chi*-square values shown in Tables 1 and 3 and the Figure indicate 4 items with significant difference between participants posttest, although this does not establish a causal relationship with the intervention used in this study. The LDA values were based on a 5-point Likert-like scale. The 4 items identified were

- I hear what someone says; I just do not remember what was said. χ2=14.77, df=3, Asymp sig=.002.
- I need to have directions repeated before I can understand them. χ2=9.77, df=4, Asymp sig=.045.
- I often get confused about what I want to say. χ2=8.18, df=3, Asymp sig=.043.
- I often get tired and lose concentration after 10 to 20 minutes. χ2=9.76, df=4, Asymp sig=.045.

DISCUSSION

Possible explanations for why the changes in run time posttest did not achieve statistical significance may be the lack of supervision of participants' food intake, inadequate support for participants to consume a variety of acceptable foods, lack of motivation/incentive to repeat the 300-meter run (study participants were not compensated), and all members of the sample not completing the requirements of the study. Additionally, running 300 meters was not a major component of all sports the participants played; subsequent investigations should include other strength or physical measures to evaluate changes. Volunteered comments received from some of the participants indicated that they felt there was merit in the premise of the study

and it may have affected their perception of improved health and academic prowess, while others stated that they expected to see greater improvements and that being mindful of reading food labels and more particular about what foods were eaten was difficult.

This study used IgG for food sensitivity testing, not the typical IgE for food allergy confirmation.[6,11,15-18] IgG food sensitivity is emerging but may not be considered established in the literature at this time.[5,19] As there is ongoing research into the validity of IgG antibody testing to indicate functional reactivity, this measure was used for convenience of specimen collection and exploratory inquiry.[13-14] Contemporary investigations are concluding that IgG antibody/antigen complex is a highly sensitive indicator of the immune response and that its presence marks the initiation of the complement system. The complement system, being responsible for the enzymatic cascade and proliferative inflammatory response, responds to the IgG antigen-antibody moiety. Work by Meulenbroek et al supports a relationship of IgG in allergen-IgE complexes, resulting in binding to B cells via complement receptor 2 (CR2) as well as to cluster designation 23 cells (CD23) and precipitation of the allergic response.[22,23]

Lines of research providing the framework for this study include those addressing individualized medicine, the human microbiome project, IgG food-sensitivity impacting the immune response and the prelude to gut inflammation, as well as food sensitivity from the diet influencing athletic performance. As recently as 2012, there was research published on the link between gut microbiota and exertional heat stroke.[24] The annual meeting of the American College of Sports Medicine (ACSM) organization also contained information about the human microbiome.[25] The ACSM article shared that bacterial biomarkers are being used for identifying disease risk, overtraining, fatigue status, and predisposition
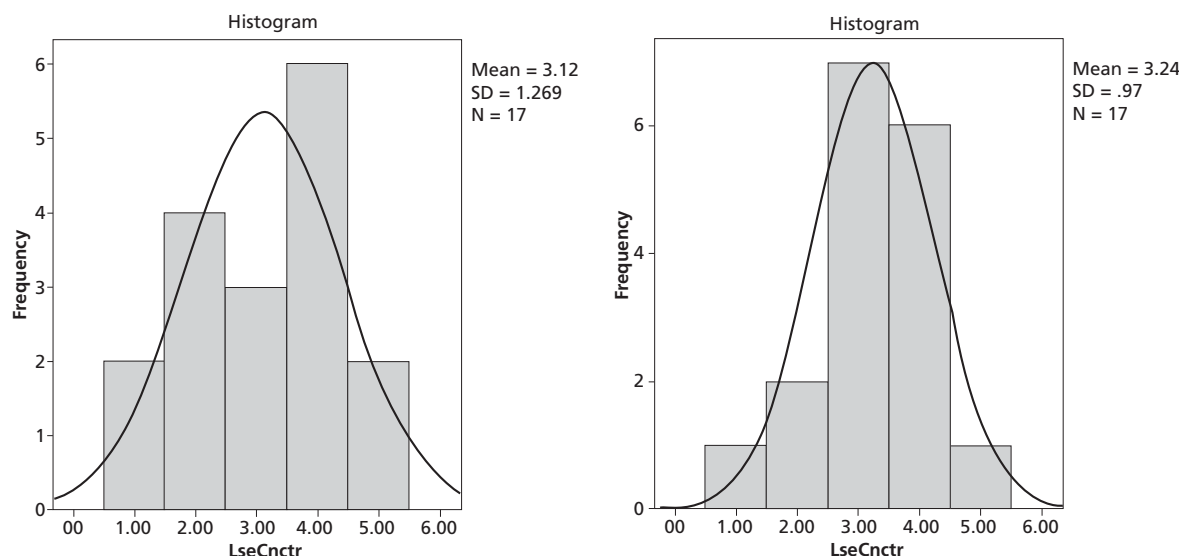
Table 3 Frequency of Learning Difficulties Assessment Items (N=17, *P*<.05)

Item		Agree Completely	Agree Somewhat	Neutral	Disagree Somewhat	Disagree Completely	Mean	SD	P value
				Scale					
I hear what someone says; I just do not remember what was said.	Pre-test	0	3	6	8	0	3.29	.77	.002
Remember/Remb2	Post-test	0	1	3	11	2	3.82	.73	
I need to have directions repeated before I can understand them.	Pre-test	1	4	1	7	4	3.53	1.28	.045
RptDir/RptDir2	Post-test	0	1	2	7	6	3.88	1.32	
I often get confused about what I want to say.	Pre-test	0	2	2	8	5	3.94	.97	.043
CnfSay/CnfSay2	Post-test	0	1	3	9	4	3.94	.83	
I often get tired and lose concentration after 10-20 minutes.	Pre-test	2	4	3	6	2	3.12	1.27	.045
LseConctr/LseConctr2	Post-test	1	2	7	6	1	3.23	.97	
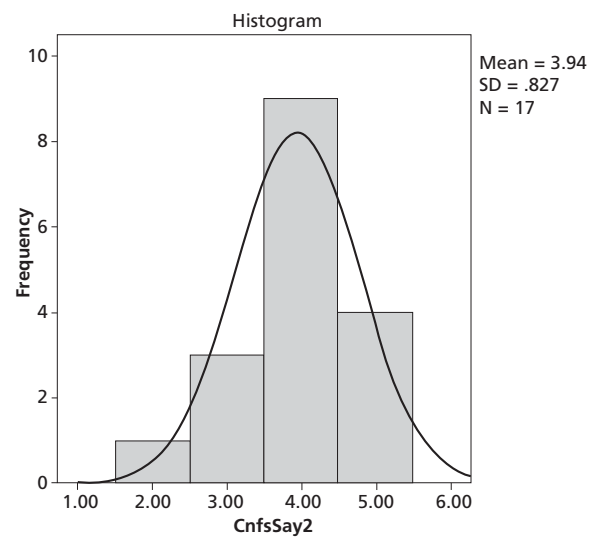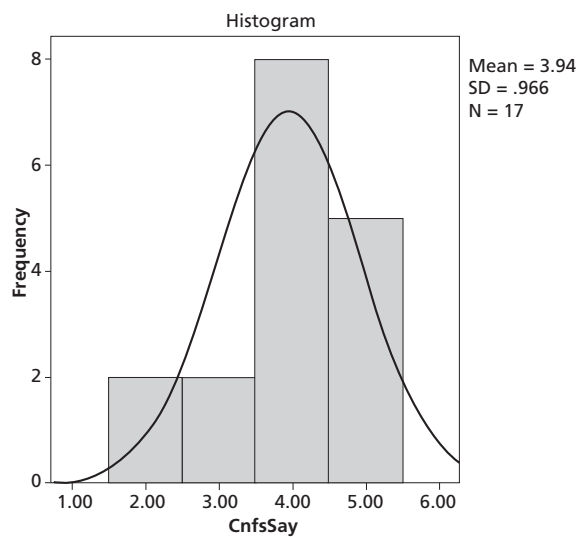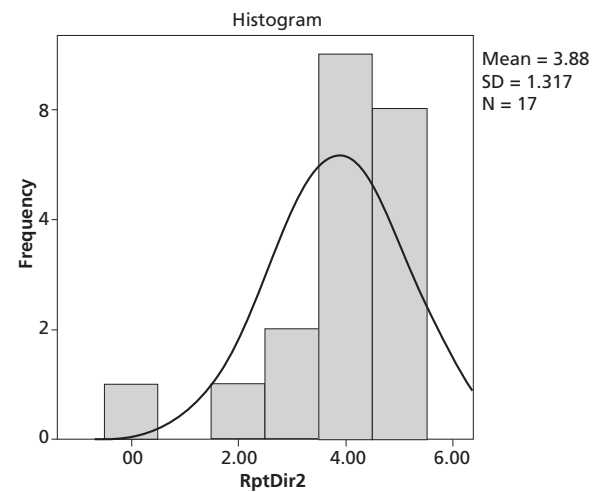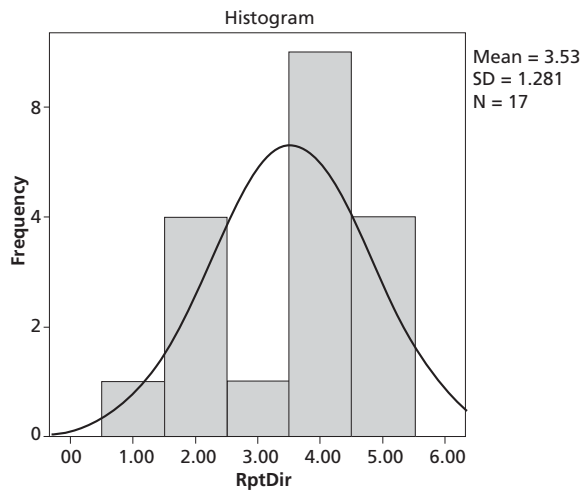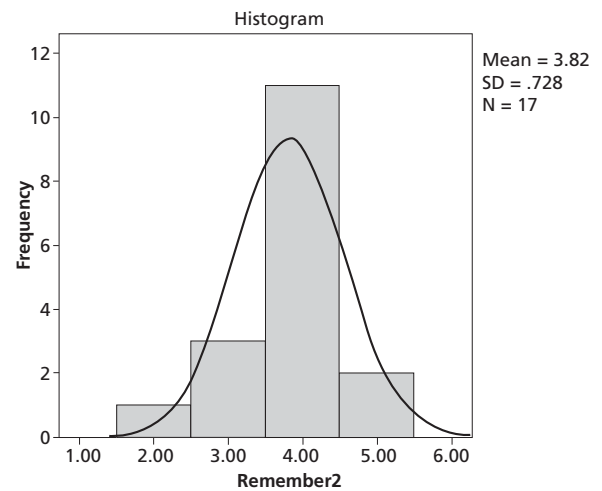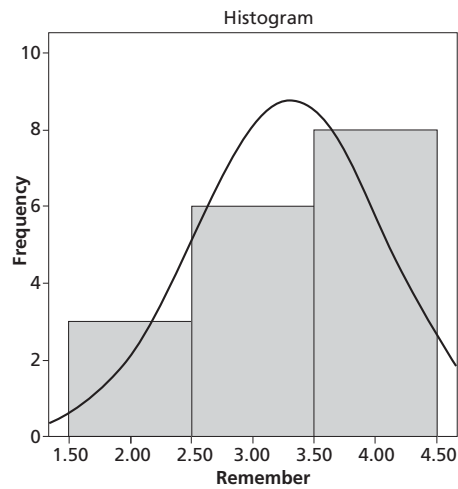
Figure Histogram Display and Frequency Scores From Learning Difficulties Assessment (N=17) (*continued on next page*).

Figure Histogram Display and Frequency Scores From Learning Difficulties Assessment (N=17) (*continued from previous page*).

to heat illness. The current study aimed to investigate improved athletic and academic (concentration) performance, which could be inferred from the foregoing by diminishing overtraining complications and avoiding fatigue and heat illness. The current study aimed to investigate improved athletic and academic (concentration) performance by analysis of IgG antibody reations and food elimination based on those reactions. The 300-meter pre- and post- run and LDA test were used as indicators of improved performance. This information may contribute to understanding gut imbalance and inflammation, as well as in athlete performance. Elaine Hsiao's presentation for TEDxCaltech, entitled "Mind-altering Microbes: How the Microbiome Affects Brain and Behavior," suggests that cognitive ability and social behavior can be linked to the type and quality of interactions between gut flora and diet.[10] Thus, research into one's proteome, metabolome, microbiome, autoantibodies, and epigenome provide evidence of the previously unprecedented opportunity to improve medical treatment and develop preventive strategies to preserve health.[26] Expanding on the prospect of personalized/individualized medicine to maximize human potential in both the physical and cognitive realms is the endeavor of this investigation.

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The Great Plains Laboratory, Inc.

William Shaw, Ph.D Director   11813 W. 77th Street, Lenexa, KS 66214   (913) 341-8949   Fax (913) 341-6207

Requisition #:   **Physician Name:**

Patient Name: **Date of Collection:**

Patient Age: **Time of Collection:**

Sex: **Print Date:**

Comprehensive IgG Food Allergy Test + C. albicans, S. cerevisiae (94)

Dairy	
Casein	7.15
Cheese	7.05
Goat Cheese	5.91
Milk	9.39
Mozzarella Cheese	4.65
Whey	8.13
Yogurt	7.27

Legumes - Beans and Peas	
Garbanzo Bean	1.96
Green Bean	3.34
Kidney Bean	4.19
Lentil	1.28
Lima Bean	1.22
Pea	1.36
Pinto Bean	3.46
Soybean	1.69

Fruit	
Apple	2.60
Apricot	1.81
Banana	2.39
Blueberry	2.45
Coconut	1.96
Cranberry	4.90
Grape	2.06
Grapefruit	4.16
Lemon	5.40
Orange	2.25
Papaya	1.78
Peach	1.67
Pear	2.60
Pineapple	2.59
Plum (Prune)	1.69
Strawberry	5.33
Watermelon	2.66

Grains	
Barley	3.61
Buckwheat	3.24
Corn	3.60
Gliadin	3.95
Millet	3.84
Oat	2.11
Rice	1.70
Rye	3.88
Sorghum	5.09
Wheat Gluten	4.34
Wheat	4.72

Fish	
Cod Fish	1.79
Crab	0.99
Halibut	1.85
Lobster	1.49
Salmon	2.89
Sardine	1.30
Shrimp	0.99
Tuna	1.98

Meat/Fowl	
Beef	6.39
Chicken	3.05
Egg White	13.63
Egg Yolk	12.91
Lamb	3.25
Pork	1.68
Turkey	2.26

Nuts and Seeds	
Almond	1.86
Cashews	2.12
Flax	2.18
Hazelnut	1.45
Peanut	3.77
Pecan	2.56
Pistachio	2.66
Sesame	2.85

Testing performed by The Great Plains Laboratory, Inc., Lenexa, Kansas. The Great Plains Laboratory has developed and determined the performance characteristics of this test. This test has not been evaluated by the U.S. Food and Drug Administration.

Appendix A.

The Great Plains Laboratory, Inc.

William Shaw, Ph.D Director   11813 W. 77th Street, Lenexa, KS 66214   (913) 341-8949   Fax (913) 341-6207

Requisition #:	**Physician Name:**
Patient Name:	**Date of Collection:**
Patient Age:	**Time of Collection:**
Sex:	**Print Date:**

Comprehensive IgG Food Allergy Test + C. albicans, S. cerevisiae (94)

Nuts and Seeds	Continued	
Sunflower		1.67
Walnut		1.62
Vegetables		
Asparagus		1.98
Avocado		1.92
Broccoli		2.50
Beet		2.01
Cabbage		2.16
Carrot		2.44
Celery		4.28
Eggplant		2.26
Garlic		3.92
Green Pepper		2.24
Lettuce		4.07
Onion		2.84
Potato		2.37
Pumpkin		2.04
Radish		2.38
Spinach		2.17
Sweet Potato		1.59
Tomato		2.69
Miscellaneous		
Candida Albicans		12.84
Cane Sugar		2.43
Cocoa		3.57
Coffee		1.98
Honey		3.13
Mushroom		3.06
Yeast, Bakers *		8.62
Yeast, Brewers *		8.40

*Saccharomyces cerevisiae

Not Significant	1.00-1.99
Low	2.00-3.49
Moderate	3.50-4.99
High	>=5

Reactivity Summary

High

Egg White	Egg Yolk	Candida Albicans
Milk	Yeast, Bakers *	Yeast, Brewers *
Whey	Yogurt	Casein
Cheese	Beef	Goat Cheese
Lemon	Strawberry	Sorghum

Moderate

Cranberry	Wheat	Mozzarella Cheese
Wheat Gluten	Celery	Kidney Bean
Grapefruit	Lettuce	Gliadin
Garlic	Rye	Millet
Peanut	Barley	Corn
Cocoa		

Low

Pinto Bean	Green Bean	Lamb
Buckwheat	Honey	Mushroom
Chicken	Salmon	Sesame
Onion	Tomato	Pistachio
Watermelon	Apple	Pear
Pineapple	Pecan	Broccoli
Blueberry	Carrot	Cane Sugar
Banana	Radish	Potato
Eggplant	Turkey	Orange
Green Pepper	Flax	Spinach
Cabbage	Cashews	Oat
Grape	Pumpkin	Beet

Testing performed by The Great Plains Laboratory, Inc., Lenexa, Kansas. The Great Plains Laboratory has developed and determined the performance characteristics of this test. This test has not been evaluated by the U.S. Food and Drug Administration.

Appendix A (cont).

The Great Plains Laboratory, Inc.

William Shaw, Ph.D Director   11813 W. 77th Street, Lenexa, KS 66214   (913) 341-8949   Fax (913) 341-6207

Requisition #:

Patient Name:

Patient Age:

Sex:

Physician Name:

Date of Collection:

Time of Collection:

Print Date:

Comprehensive IgG Food Allergy Test + C. albicans, S. cerevisiae (94)

Comments

The IgG Food Allergy Test measures the relative presence of IgG antibodies to specific food proteins. The patient's serum is introduced to protein extracts from each of the different foods. If food-specific binding occurs between the antigen proteins and the patient's IgG serum antibodies, a symptomatic reaction to that food is possible. A food elimination diet can be established based on results of this test and improvement of symptoms can be monitored.

High levels of IgG antibodies to Candida, a genus of yeast, have been found in patients who scored high on a questionnaire regarding symptoms of yeast overgrowth, like sugar cravings which can improve with antifungal therapy. In a published study, IgA or IgM antibodies to *Candida* did not correlate with questionnaire scores. IgG antibodies to *Candida* may be due to past infections and therefore do not indicate a current infection. However, *Candida* antibodies may trigger autoimmune disease. *Candida* antibodies react with virtually all human organs, including the brain. In one study, individuals with pituitary malfunction had *Candida* antibodies that also reacted to a human pituitary protein. *Candida* antibodies are elevated in Crohn's disease, cystic fibrosis, and cancer. Individuals with cancer and elevated IgG antibodies to *Candida* died on average one year sooner than individuals with the same type of cancer and normal amounts of IgG antibodies to *Candida*. A wide range of disorders have been linked to *Candida* including depression, chronic fatigue, thyroid disorders, autism, multiple sclerosis, vulvodynia. Use of antibiotics, oral contraceptives, chemotherapy, and anti-inflammatory steroids greatly increase susceptibility to *Candida*. Overgrowth of *Candida* may also cause a rise in cases of food allergies.

IgG antibodies to *Saccharomyces cerevisiae* are prevalent in inflammatory bowel disease, Crohn's disease, celiac disease, and Behcet's disease, while not usually elevated in ulcerative colitis. High amounts of antibodies to either *Saccharomyces cerevisiae* or *Candida albicans* may also cross-react with other *Candida* species or *Saccharomyces boulardii*. Individuals with high amounts of antibodies to *Candida albicans* or *Saccharomyces cerevisiae* might react poorly to *Saccharomyces boulardii* probiotic supplements because of this cross-reactivity.

High amounts of antibodies to wheat, gluten, rye, or barley are common in celiac disease. However, most people with these elevated antibodies do not have celiac disease, but may still benefit from exclusion of these foods from the diet. The Celiac Disease Test with blood serum can confirm celiac disease. To determine if enough serum is available, contact The Great Plains Laboratory, Inc. (test is not available for bloodspot samples). The Celiac Disease Test should be done prior to implementation of a gluten-free diet to avoid false negative results. For more information on the Celiac Disease Test, please see The Great Plains Laboratory website, www.gpl4u.com <http://www.gpl4u.com>.

Appendix A (*cont*).

Daily Food Diary for [Date]

Food Group	Food Name and Amount
Breakfast	
Grains/Starches	
Vegetables	
Fruits	
Dairy	
Protein	
Fats/Sweets	
Beverages	
Comments	
Snack	
Lunch	
Grains/Starches	
Vegetables	
Fruits	
Dairy	
Protein	
Fats/Sweets	
Beverages	
Comments	
Snack	
Dinner	
Grains/Starches	
Vegetables	
Fruits	
Dairy	
Protein	
Fats/Sweets	
Beverages	
Comments	
Snack	

Appendix B.

Weekly Food Diary

Instructions: keep track of what you eat each day. Fill out the sheet. Be sure to include not just what you ate but how much (such as 2 slices of a large pepperoni pizza, or a sandwich with … list all the fillings). Snack and beverages are also important to include. Please be as accurate as you can. We are looking at the types of food and nutrient values, not calories.

	Monday 4 / 21	Tuesday 4 / 22	Wednesday 4 / 23	Thursday 4 / 24	Friday 4 / 25	Saturday 4 / 26	Sunday 4 / 27
FOOD CONSUMED							
Breakfast				Nature Valley protein bar	cup of fruit		Apple pastry
Snack				fruit			
Lunch	Stuffed jalapenos Shrimp	large salad	large salad	Starkist Tuna 2.6oz	3 tacos - corn shell	Pizza thin crust wings	Steak nachos & chips/salsa
Snack		fruit			fruit		
Dinner	Stuffed jalapenos Shrimp	brown rice & shrimp	brown rice & shrimp	large salad	Burger green beans	Pork tender-loin brown rice tomatoes	Mostacholi small salad
Snack			fruit	cup of fruit		fruit	
Beverages/Water	5 bottles of water	4-5 bottles of water	4-5 bottles of water	4-5 bottles of water	4-5 bottles of water	4-5 large glasses of water	4 bottles of water

	Monday 4 / 28	Tuesday 4 / 29	Wednesday 4 / 16	Thursday 4 / 17	Friday 4 / 18	Saturday 4 / 19	Sunday 4 / 20
FOOD CONSUMED							
Breakfast		cup of fruit	Protein bar Nature Valley		2 cups of fruit		
Snack							
Lunch	Starkist Tuna 2.6oz	cup of fruit	Salad - large glass of water	Starkist tuna 2.6oz	Soup - chicken noodle	turkey sandwich 2 cups of fruit	omlet - spinach - peppers - ham/turkey 4 pieces of bacon cup of fruit
Snack	fruit			a peach	fruit		
Dinner	chicken green beans small salad brisket	Brown rice & shrimp	Brow rice & shrimp	3 cornshell enchiladas	grilled chicken salad	Stuffed jalapenos Shrimp green beans	Stuffed jalapenos Shrimp
Snack				fruit			
Beverages/Water	3 bottles of water 2 glasses of tea	4 bottles of water	4 bottles of water	4-5 bottles of water	4-5 bottles of water	4-5 bottles of water	water

Appendix B (cont).

Weekly Food Diary

Instructions: keep track of what you eat each day. Fill out the sheet. Be sure to include not just what you ate but how much (such as 2 slices of a large pepperoni pizza, or a sandwich with … list all the fillings). Snack and beverages are also important to include. Please be as accurate as you can. We are looking at the types of food and nutrient values, not calories.

	Monday 4 / 22	Tuesday 4 / 23	Wednesday 4 / 24	Thursday 4 / 25	Friday 4 / 26	Saturday 4 / 27	Sunday 4 / 28
				FOOD CONSUMED			
Breakfast	Quaker rice cake tbsp peanut butter	Strawberry (1.5c) wheaties 1 cup almond milk	1.5 c Strawberry wheaties 1 cup almond milk	banana banana nut granola bar	1 cup waffle 2 tbsp peanut butter 3 tbsp syrup		banana
Snack	cup carrots		1 bag doritos cool ranch				
Lunch	Healthy Choice potstickers frozen dinner cup pretzel crisps 2 tbsp guacamole	Healthy Choice sweet sour chicken frozen dinner	4 eggs, scrambled 1 tbsp ketchup 1/2 c. cantaloap	Healthy Choice frozen dinner - Basil chicken	1 tortilla 2 tbsp peanut butter 1 banana 1/4 c wheat thins	subway 6" - flatbread - turkey - lettuce - tomato - light mayo 1 choc.chip cookie	tacos - 2 tortilla - 1/2 cup ground pork - 1/2 c lettuce - 2 tbsp salsa
Snack	3/4 cup cheesecake	banana granola bar (sunbelt)	Chocolate Chip granola bar	- strawberry smoothie - 1 cup strawbe. - 1/2 cup almond milk - 1/4 c oats		4 hershey kisses	
Dinner	Sushi 2 cali rolls 1 tbsp eel sauce	shrimp tacos - 2 tortillas - 8 cup shrimp - 4 tbsp guac - 1 c lettuce - 4 tbsp salsa	Sushi - Cali roll - 3 crab rangoon	1.5 cups spaghetti 1 cup green beans 1 cup lettuce with dressing 1/4 cup fruit + pizza	1.5 cups cheesesticks 2 tbsp marinara	3 c Wendy's salad - chicken - apples - pomagranate vinaigrette - feta cheese	1 c lettuce 1 tbsp ranch 1 c mash potatoes w/ cheese 1 c brisket w/ barbecue sauce ··· 1 roll w/ butter
Snack		1 cup carrots 1 sugar cookie	mcdonalds - 6 chicken menuggets - 1 c fries	banana 1 cup white chocolate carmel mocha		1 tortilla - 2 tbsp peanut butter - 2 tbsp jelly	2 chocolate chip/carmel cookies
Beverages/Water	60 oz water	70 oz water 2 cups lemonberry slush'n	70 oz water 10 oz root beer 5 oz Emergenc	40 oz water	2 long islands 1 AMF 80 oz water	1 can root beer 40 oz water 8 oz orange gatorade	10 oz lemonade 30 oz water 20 oz redbull vodka

Appendix B (*cont*).

GPL_UCM IgG Study for Athletic Performance Please ☑ the most appropriate box.	Agree Completely	Agree Somewhat	Neutral	Disagree Somewhat	Disagree Completely
	(1)	(2)	(3)	(4)	(5)
I hear what someone says: I just do not remember what was said.					
I have a difficult time listening to lectures.					
Listening in class is hard for me.					
I find myself getting lost during lectures.					
Taking notes makes it hard for me to follow a lecture.					
Several people have told me that I do not remember much of what I'm told.					
When I listen to someone talk, it's very easy for me to get distracted.					
I constantly daydream during class lectures.					
No matter how hard I try, lectures do not make much sense to me.					
I have trouble understanding spoken directions.					
I have a hard time understanding what people are saying.					
Words that sound alike are confusing to me.					
I need to have directions repeated before I can understand them.					
I often get confused about what I want to say.					
It is hard to listen unless I can see the person who is talking.					
It is hard for me to listen to a lecture and take notes at the same time.					
I often get tired and lose concentration after 10-20 minutes.					
It is hard for me to concentrate in class.					
I often have trouble remembering particular words.					
I do not retain much of what I read.					
When trying to read, the least little thing can distract me.					
Even when I am concentrating I have trouble remembering what I just read.					
It is difficult for me to read for more than 10-20 minutes.					
Name:					

Appendix C.