

Food elimination diet among college students affecting physical performance and learning

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Abstract

Introduction: A follow-up study conducted among collegiate athlete's was performed to determine if an IgG directed 14-day food elimination diet (FED) would have a positive impact on grip strength, 100(x3) meter run time, waist and hip measurements and responses to the Learning Difficulties Assessment among enrolled physically active college students.

Methods: A quasi-experimental, nonrandomized, repeat measure study without a control group was conducted at the primary investigators educational institution. Students (n=49) were invited to participate in the study where baseline IgG food sensitivity was obtained using a Dried Blood Spot (DBS) specimen (Great Plains Laboratory, Lenexa, KS, USA). Students performed grip strength, waist measurement, hip measurement, 100 meter run, and Learning Difficulties Assessment (LDA) survey. A registered dietitian met with subjects to guide the 14-day food elimination diet based on results of the DBS specimen.

Results: Descriptive statistic findings revealed that physical measures, e.g., run time, grip strength, and waist circumference for males and females as well as 19 of 23 items on the Learning Difficulties Assessment were improved after the two week food elimination diet.

Discussion: Although the grip strength did not achieve statistical significance human physiologic gains as well as athletic competition (strength, run time) are measured on a less rigid model for determining improvement such that small differences reflect positive changes. The LDA did reveal some significant changes post FED and contributes to the growing body of literature about the gut brain connection.

Conclusions: Expanding this study to include individuals enrolled in higher education without the prerequisite of membership on a collegiate athletic team revealed improvement in physical strength, run time, biometrics and responses on the Learning Difficulties Assessment survey compared to the initial pilot. Current research supports the relationship between gut health and brain function. Further study of eliminating specific foods based on IgG food sensitivity impacting cognition as well as physical prowess is warranted.

Introduction

Exploding in the scientific literature is research surrounding human surface mucosal and intestinal (gut) microorganisms. The ensemble of genes in these intestinal microbe populations constitutes the human microbiome [1]. Using the search terms "human microbiome" within Google Scholar revealed 26 300 articles published since 2011. The Human Microbiome Project has further identified and classified the species and enzymes relevant to the intestinal flora [2]. Thus, the influence of the microbiome in health and disease continues to mount.

One of the largest longitudinal studies conducted by MIT, Harvard, and Massachusetts General Hospital found a correlation between changes in gut microbiota and the initiation of Type I Diabetes Mellitus [3]. This study found a three way link between antibiotic use during infancy, changes in gut bacteria, and disease states later in life. Specifically examined in their longitudinal study was the mode of maternal delivery and feeding of newborns resulting in variant populations of microbiota in the infants' intestinal tract. Results also state that imbalances in the gut microbiome have been associated with infectious diseases, allergies, autoimmune disorders and obesity later in life [3]. Pediatric antibiotic usage has been found to induce imbalances in the gut microbiota [4]. Childhood antibiotic use, whether over-the-counter or by prescription, is linked to gut microbiome changes and possibly diseases later in adulthood [5]. Critical to health and well-being is the variety and ratio of gut microbiota. When this microbial

milieu is altered food sensitization (a precursor to gut inflammation) and food allergy can result [6].

Information from the investigation of the human microbiome suggests that therapeutic dietary interventions may be of benefit [7]. Along with dietary modifications may be strategies of immune modulation and microbiota restorative therapies to alter disease course outcomes [8]. According to Khanna and Tosh (2014) several disease states, such as attention deficit/hyperactivity disorder, autism, chronic fatigue syndrome among others, may have their pathogenesis from disorganized relay of communication between the gut immune system and the brain [9]. Dysregulation of the gut-brain axis may be the model for such disorders as irritable bowel syndrome via the hypothalamus-pituitary-adrenal axis where disruption of appropriate cross-talk between brain and gut exist [10]. Hornig posits that "microbes might participate in the pathogenesis of neuropsychiatric illness (depression) by triggering the production of autoantibodies that bind to brain targets" [11].

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Considering the plethora of agents that may impact the optimal functioning of the human digestive system, e.g., medications, processed food intake, satisfactory digestive enzyme production and release, chemical toxins in food and water, electromagnetic radiation, emotional stressors, sleep patterns, overuse of antacids, antihistamines, histamine-2-blockers all can have deleterious effects [12]. When digestion is impaired resulting in partially digested food, such as proteins and peptides, the gut microbiota changes. Altered gut microbiota release endotoxins known as lipopolysaccharides. The mechanism by which lipopolysaccharides cause inflammation is through opening tight junctions leading to damaged occludin, zonulin, and actinomycin which then allows these undigested proteins and peptides to cross the intestinal mucosal layer, migrate to regional lymph nodes and enter the blood stream [13]. Once in the blood stream these proteins and peptides can bind to tissues initiating an immune response and autoimmunity [12].

Similar to the components that predispose to disruption of the digestive process are factors that contribute to systemic inflammation, e.g., poor dietary choices, physical inactivity, obesity, smoking, excessive alcohol consumption, *altered gut permeability*, dental caries, quality sleep, and vitamin D deficiency [14]. An estimated 100 million people are afflicted with food-related inflammatory conditions worldwide [15]. Concomitantly, an inflamed gut displays diminished diversity and complexity, compromising immune responsiveness and homeostasis [16]. To address this distortion within the digestive system manipulating the microbiota through diet may provide a viable avenue of health benefits. Vojdani (2015) states that the gold standard for identifying dietary contributors to gut imbalance and systemic inflammation may be with food reactions via the elimination-provocation diet protocol [13]. One specific test to identify aggravating foods in the diet is with Immunoglobulin G (IgG) antibody food antigen reaction. Shaw (2014) explains that IgG antibody food sensitivity/allergy testing is an effective means of isolating aggravating foods due to IgG1, IgG2, and IgG3 not exchanging heavy and light chains forming bispecific antibodies, rather these antibodies form large immune complexes contributing to inflammation [17].

Others feel that not enough research has been conducted to confirm the specificity of IgG antibody testing for confirming food allergy or other clinically meaningful outcomes [13,18]. Most all research has addressed correlation between gut dysbiosis and disease states. This study examined a 14-day food elimination diet based on IgG directed food sensitivity test with repeat biometric, cognitive, and physiologic measures to determine if this brief intervention could influence significant physical and learning parameters towards optimizing physical and mental performance.

Methods

During the spring 2015 semester currently enrolled college students (mean age 21.05 y) were invited to participate in this study. Research study announcements were made from principle investigators in their classes and shared with other faculty in the department. Institutional Review Board approval was obtained and informed consent documents were shared with all subjects prior to data collection by the principle investigators at their teaching institutions. As this arm of the study included those individuals that were not currently members of an athletic team the additional Physical Activity Readiness Questionnaire (PAR-Q) was added. Similar to the distribution of males and females at the principle investigators institution there were 25 female and 18 males completing all components of the study (N=43).

A one-group repeated measures, quasi-experimental follow-up study without a control group was conducted to see if extending the subject pool to physically active college age students rather than exclusively college athletes performed previously would result in significant changes in dependent variables of grip strength, waist circumference, hip circumference, 100-meter run time, and responses on the Learning Difficulties Assessment (LDA). Subjects electing to participate met with the principle investigators to complete consent forms, demographic survey, LDA, perform seated or standing grip strength using a hand-dynamometer (Lafayette Instruments Model J00105), 100-meter run time (indoor track), and provide dried blood spot (DBS) specimen for IgG analysis of 93 foods and *Candida albicans*. Subjects were allowed to ask questions about the study and instructed to meet with a registered dietician after IgG analysis results were received. During the meeting with the registered dietician subjects were counseled on how to follow a 14-day food elimination diet based on their IgG antibody food antigen reaction report results. Students were also asked to keep a record of the foods consumed during the 14-day food elimination trial.

Results

Data from all subjects were entered into the SPSS vs. 19 (IBM Corp. Armonk, New York) statistical software program for analysis. Descriptive and non-parametric (one sample k-repeated measures) statistics were collected (Table 1). Of the physical measures both male

Table 1. Mean and Standard Deviation Data from Food Elimination Diet Study.

Item	Pretest Mean ± SD	Posttest Mean ± SD	Aymp. Sig. (p ≤ .05) Pretest; posttest
Run (N=43)(100mx3)	51.37 ± 10.79	51.21 ± 6.02	.011
Grip Strength (n=26)	94.04 ± 21.32	98.98 ± 24.55	.053
Waist (male n=13)	33.77 ± 1.75	33.27 ± 2.13	.043
Waist (female n=13)	30.62 ± 3.03	29.54 ± 2.74	.014
Hip (male n=13)	39.04 ± 3.72	38.54 ± 3.60	.372
Hip (female n=13)	37.65 ± 2.30	36.96 ± 1.76	.057
Remember (N=43)	3.35 ± .098	3.67 ± .094	.041
LstnLect	3.25 ± 1.21	3.46 ± 1.03	.117
LstnClass	3.67 ± 1.06	3.90 ± 1.04	.056
LostLect	3.46 ± 1.22	3.53 ± 1.00	.773
NotesLct	3.88 ± 1.11	4.07 ± 1.10	.227
RmrbTold	3.88 ± 1.05	4.04 ± 0.90	.266
DstrcTlk	3.14 ± 1.17	3.49 ± 1.14	.057
Daydream	3.30 ± 1.16	3.40 ± 1.14	.489
SnsLect	4.07 ± 0.98	4.32 ± 0.71	.033
SpknDir	3.93 ± 0.96	4.02 ± 0.80	.501
Undrstnd	4.11 ± 0.79	4.37 ± 0.76	.022
WrdsCnfs	4.40 ± 0.65	4.46 ± 0.59	.513
RptDir	3.60 ± 1.25	3.65 ± 1.23	.869
CnfsSay	3.62 ± 1.17	3.72 ± 1.11	.462
SeeTalk	3.60 ± 0.88	3.67 ± 1.04	.647
TakeNtes	3.88 ± 1.05	3.93 ± 1.06	.624
LseCnctr	3.35 ± 1.17	3.46 ± 0.96	.429
Cncntrte	3.65 ± 1.15	3.70 ± 1.06	.728
PartWrds	3.86 ± 1.12	3.81 ± 1.05	.858
RetainRd	3.46 ± 1.16	3.32 ± 1.15	.235
DistrcRd	2.67 ± 1.27	2.58 ± 1.28	.640
RmbrRd	3.04 ± 1.33	3.44 ± 1.18	.004
ReadTime	2.84 ± 1.46	3.39 ± 1.24	.001

Table 2. Repeat Measure Analysis of Food Elimination Diet Data.

Item	Rank	N	Mean Rank	Z	Asym Sig (p≤.05)
GripStr2-GripStrg	Neg.	8	11.38	-1.93	0.053
	Pos.	17	13.76		
RunTime2-RunTime	Neg.	30	20.90	-2.55	0.011
	Pos.	11	21.27		
WaistM2-WaistM	Neg.	5	4	-2.02	0.043
	Pos.	1	1		
WaistF2-WaistF	Neg.	10	7	-2.45	0.014
	Pos.	2	4		
HipMale2-HipMale	Neg.	6	5	-0.89	0.372
	Pos.	3	5		
HipFem2-HipFem	Neg.	7	6.57	-1.9	0.057
	Pos.	3	3		
Remb2-Remember	Neg.	7	10.57	-2.05	0.041
	Pos.	16	12.63		
LstnLec2-LstnLec	Neg.	9	9	-1.56	0.117
	Pos.	13	13.23		
LstnCls2-LstnCls	Neg.	6	8.5	-1.91	0.056
	Pos.	13	10.69		
LostLec2-LostLect	Neg.	9	11.94	-0.29	0.773
	Pos.	12	10.29		
NotesLec2-NotesLct	Neg.	6	9.83	-1.21	0.227
	Pos.	12	9.33		
RembrTld2-Rmbrtld	Neg.	8	10.63	-1.11	0.266
	Pos.	13	11.23		
DstrcTk2-DstrcTlk	Neg.	8	14.06	-1.91	0.057
	Pos.	19	13.97		
Daydrm2-Daybream	Neg.	7	10.07	-0.69	0.489
	Pos.	11	9.14		
SnsLect2-SnsLect	Neg.	3	5.5	-2.14	0.033
	Pos.	10	7.45		
SpknDir2-SpknDir	Neg.	8	6.94	0.67	0.501
	Pos.	8	10.06		
Undrstd2-Undrstnd	Neg.	4	8	-2.3	0.022
	Pos.	13	9.31		
WrdsCnf2-WrdsCnfs Neg.	Neg.	8	9	-0.65	0.513
	Pos.	10	9.9		
RptDir2-RptDir	Neg.	11	14.23	-0.16	0.869
	Pos.	14	12.04		
Item	Rank	N	Mean Rank	Z	Asym. Sig (p<.05)
CnfsSay2-CnfsSay	Neg.	9	9.61	-0.73	0.462
	Pos.	11	11.23		
SeeTalk2-SeeTalk	Neg.	13	17.38	-0.46	0.647
	Pos.	18	15		
TkeNtes2-TakeNtes	Neg.	11	11.18	-0.49	0.624
	Pos.	12	12.75		
LseCnct2-CseCnctr	Neg.	12	11.17	-0.79	0.429
	Pos.	13	14.69		
Cncntr2-Cncntrte	Neg.	11	11.59	-0.35	0.728
	Pos.	12	12.38		
PartWr2-PartWrds	Neg.	14	14	-0.18	0.858
	Pos.	13	14		
RetnRd2-RetainRd	Neg.	12	11.17	-1.19	0.235
	Pos.	8	9.5		
DistrRd2-DistrRd	Neg.	16	12.94	-0.47	0.64
	Pos.	11	15.55		
RmbrRd2-RmbrRd	Neg.	5	10	-2.87	0.004
	Pos.	18	12.56		
Rdtime2-ReadTime	Neg.	4	8.5	-3.3	0.001
	Pos.	19	12.74		

Table 3. Sample results from the Comprehensive IgG Food Allergy Test™ (N=43).

Item	Minimum	Maximum	Mean	SD
<i>Food Items</i>				
Casein	1.14	11.29	4.50	2.47
Cheese	1.10	10.42	4.56	2.30
Goat Cheese	0.99	6.61	2.52	1.20
Milk	1.17	8.91	3.72	2.00
Moz. Cheese	0.93	9.37	3.18	1.90
Whey	1.28	8.61	4.16	2.07
Yogurt	1.17	9.03	3.73	2.08
Gliadin	1.20	9.82	3.69	1.95
Wheat Gluten	0.98	8.43	3.76	1.72
Wheat	0.95	7.43	3.17	1.78
<i>Candida Items</i>				
Candida albicans	1.12	19.21	8.22	4.22
Sugar	1.07	3.47	1.54	0.40
Baker's Yeast	1.33	13.35	3.94	2.26
Brewer's Yeast	1.22	12.77	3.22	2.11

Food Items Scale=Not Significant 1.00-1.99; Low 2.00-3.49; Moderate 3.50-4.99; and High >5.00 while the ranges for the Candida scale were Not Significant <3.49; Low 3.50-6.99; Moderate 7.00-14.99; and High >15.00.

and female waist circumference decreased and five of 23 items on the LDA increased significantly post intervention (Table 2). Achieving statistical significance was an improvement in 100 meter run time, initial $x = 17.64$ seconds, $s.d. = 2.45$ and after 14-day food elimination diet (FED) $x = 17.07$, $s.d. = 2.00$, $p = .011$. The comprehensive IgG Food Allergy test plus *Candida albicans*, *Saccharomyces cerevisiae* dry blood spot food antigens and Candida scales can be viewed in Table 3. The LDA used a 5-point Likert like scale with 1 representing agree completely and 5 representing disagree completely [19]. Data from the dairy and grains portions of the DBS are included for average values with this population (Table 3) as the majority of reactivity was found within these food groups. Examples from the values from the *Candida albicans*, *Saccharomyces cerevisiae* food items are also included. A sample DBS report is included as Appendix A.

Discussion

Expanding the study to include students from the general university population supported previous findings with the LDA for “I hear what someone says: I just do not remember what was said” having statistical significance post intervention $n = 43$, $z = -2.05$, $p = .041$ [19]. Other LDA items revealed unique attribute changes from the prior study, including the following (N = 43):

- No matter how hard I try, lectures do not make sense to me, $z = -2.14$, $p = .033$,
- I have a hard time understanding what people are saying, $z = -2.30$, $p = .022$,
- Even when I am concentrating I have trouble remembering what I just read, $z = -2.87$, $p = .004$
- It is difficult for me to read for more than 10-20 minutes, $z = -3.30$, $p = .001$. Improving students’ ability to understand, read, and remember after FED may encourage positive dietary habits and less academic stress in this population. Although the time frame for this study was very brief there were significant changes in waist measurements for both males and females following the FED, males: $z = -2.02$, $p = .043$ and females: $z = -2.45$, $p = .014$. These findings

contribute to the health measure of fitness for waist hip ratio, smaller girth indicating a possible decrease in gut inflammation, and less abdominal adipose an important marker for positive health outcomes.

In the physical competitive arena a split second or one pound can mean the difference between placing in the top of the field or not. The run time did express statistical significance as any improvement in run time can be a major contributor to success. Some subjects remarked that they “felt” less out of breath following the run test and that they “felt” more strength equally in both arms although both arms were not examined in this study. The grip strength test was also improved after FED, though not statistically relevant. Given that the demographic survey associated with this study did not ask about infant antibiotic usage, hours of sleep, exposure to sun during the recommended hours of the day, or current dental caries these are a few of the factors that need to be addressed in future studies. Due to lack of incentives/participation recruitment efforts/grant funding as well as time constraints involved with completing the requirements for this study within one academic semester, a control group was not included. For the future the researchers would like to include a control group, extend the timeframe of the FED to four weeks, and if possible provide the specific foods based on the subjects IgG reactivity report. With the overwhelming volume of research dedicated to the connection between the gut and the brain as well as the blossoming field of personalized medicine geared toward effecting optimal health outcomes, providing assessments such as the IgG food antigen/ *Candida albicans*, *Saccharomyces cerevisiae* would be a valid means to effect both of these emerging fields of study surrounding the human gut microbiome influence on cognition and physical prowess. Examining the sequence of the study within an academic semester may also contribute to understanding facets of the diet/gut/learning interaction process that facilitates both academic and physical performance for ideal health gains. This study contributes to the literature of benefit potential and ability to draw conclusions toward FED improving physical performance, LDA scores, and body metrics.

Practical application

This study supports the necessity for individuals, especially young adults whose physiology can respond with large gains in health with minimal dietary effort/alterations, to examine more closely their current food intake. Personalizing the diet using tests such as the IgG antibody/food antigen reaction to guide consumption can yield surprising and positive results among college students whether collegiate athlete or not [20]. Cost for lab testing may be a deterrent for college students and the findings indicate that excluding dairy and grains may be warranted for the majority of students [21]. Future investigation into the components within these food groups (dairy and grains) that contribute to IgG reactivity is an area for examination. Self-evaluation by means of exclusion/provocation of food items may also benefit young adults for improved health gains and can be conducted using non-invasive means as an estimate of reactivity between subject and food item [22] Since the preponderance of evidence concludes that the gut microbiota affects physiology in disease and is necessary for homeostasis this avenue of specificity for food selection may be the next strategy for optimizing human performance [23,24].

Conclusion

This study supports the present day findings of altering food consumption based on a host specific assessment of IgG antibody food antigen evaluation to improve selected areas of learning difficulty, body metrics (waist circumference) and potential for faster run speeds.

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