Effects of Veganism on the Performance of Female High School Athletes

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ABSTRACT

Veganism is growing rapidly in modern society; many people are adopting the diet, excluding all animal-derived products from their eating habits. With the newfound popularity, various questions have risen regarding the sustainability and effects of the diet. Previous research has examined the effects of veganism on athletic performance and general health, yet a major demographic and knowledge gap remained. The goal of this study was to fill these gaps by determining the effects of veganism on the athletic and academic performance of competitive female high school athletes. A correlational analysis and design-based case study (DBCS) were implemented to examine correlation and causation between veganism and athletic and academic performance. The correlational analysis utilized data collected from a survey broadcasted to female high school athletes around Hillsborough County, Florida. The DBCS followed eleven competitive female high school athletes through a six-week period examining any changes throughout a switch from an omnivorous diet to a vegan diet. Data analysis led to the conclusion that veganism has a varying, but slightly positive effect on academic and athletic performance.

Introduction

Between 2014 and 2018, veganism increased by 600% in the US, and it has only grown since then (Krol et al., 2020). The exclusion of all animal-derived products in the diet has raised much skepticism. However, easily accessible resources, knowledge, and vegan products have allowed for the vegan diet to explode. Vegan products were now available at most grocery and convenience stores; guidelines have been released to provide people with suggested intakes, recipes, and foods to receive an adequate intake of nutrients and calories; the prevalence of plant-based dietitians has grown, providing clinical advice to those that are skeptical of the diet's sustainability. Many studies have been conducted regarding the benefits and risks of the abstinence of all animal products in one's diet. There are some risks posed by the low absorption of nutrients from many plant foods; deficiencies in iron, various amino acids, zinc, vitamin B12, docosahexaenoic acid (DHA) and α-linolenic acid (ALA) fatty acids, and some other nutrients are possible (Sakkas et al., 2020). Despite this, a well-planned vegan diet full of legumes, grains, vegetables, fruits, nuts, seeds, and vegetable oils and fats provide redeeming factors (Sakkas et al., 2020).

Pre-existing research has put forth numerous benefits to following an entirely plant-based diet, including reduced risk of cardiovascular disease, type 2 diabetes, obesity, hypertension, and some cancers (Shaw et al., 2022). Furthermore, many professional athletes have adopted a vegan diet to enhance their athletic performance. Sport stars such as the Williams sisters, two of the best competitors in women's tennis, and Mike Tyson, a highly successful heavyweight boxer, are among the abundance of plant-based athletes (Frazier et al., 2021). Improvements in recovery, sleep, and cardiovascular health can be causes of this plant-based movement seen in professional sports (Krol et al., 2020; Sakkas et al., 2020). Additionally, pre-existing research has presented positive correlations between a healthy diet and academic performance, though not exclusively focused on veganism (Naveed et al., 2020; Dumuid et al., 2017). With all this data on the benefits of a plant-based diet on athletic performance, a lack of data on its effects on academic performance, and limited knowledge on veganism in adolescents, a new question has arisen: how does a

vegan diet effect academic and athletic performance in competitive female high school athletes in Hillsborough County?

Gap In Existing Research

The research presented below focuses on various perspectives regarding the effects of diet on academic and athletic performance, sleep, and overall health. There are no existing studies focusing on both academic and athletic performance and the various factors that affect them. The only study found with similar guidelines was conducted by Priyanka Pareek and Syedamc Ayesha in India (2015). They focused on the effects of vegetarianism on schoolgirls between the ages of 13 and 15 by conducting surveys and field tests (2015). However, the current study will provide information about the effects of veganism on competitive high school female athletes aged 14-18 in Hillsborough County by conducting surveys and a design-based case study (DBCS). Additionally, limited research is available on the effects of veganism in academics and athletics in general as it has been the minority for many years (Sengul, 2022; Naveed et al., 2020; Shaw, 2022). The goal of this research is to relinquish this empirical gap by examining both academic and athletic effects of veganism, with hopes to provide insight on how diet might help or harm a female athlete's high school career.

Literature Review

Basics of Veganism

Veganism is the exclusion of all animal-derived products, including dairy, meat, eggs, gelatin, seafood, and more. With the average American diet being made mostly of animal products, a vegan diet poses many challenges to the American perception of diet (United States Department of Agriculture, 2018). A vegan diet contains high amounts of nuts, grains, seeds, legumes, fruits, and vegetables (Frazier et al., 2021; Sakkas et al., 2020). This leads to high intakes of carbohydrates, fiber, and healthy fats. Tofu, tempeh, beans, quinoa, and rice are also common in a vegan diet.

Most athletes following a plant-based diet will implement a 60/20/20 plan- receiving 60 percent of calorie intake from carbs, 20 from protein, and 20 from healthy fats. As a strength athlete this ratio might be changed to 50/25/25, or 70/15/15 for an endurance athlete (Frazier et al., 2021). Athletes need to test different ratios to find which ratios work best for their athletic goals, but once figured out, proper nutrition will fuel their training and could enhance their performance.

Possible Deficiencies

The availability of protein in a plant-based diet is often questioned, and although it is not as easily acquired as through animal products, plant-based foods can support the protein needs of a person. There are nine amino acids that are considered "essential"- they cannot be synthesized by the body and must be digested instead. Out of these nine, lysine and leucine are the hardest to acquire through plant-based foods; however, they are present in legumes and thus are available to vegans (Rogerson, 2017). Special attention would need to be paid to protein consumption, but it is possible to obtain all necessary amino acids.

Other deficiencies are possible when following a vegan diet, such as DHA and ALA. These fatty acids are commonly found in fish, and therefore limited to vegans, yet they can be consumed through vegetable oils and some grains (Sakkas et al., 2020). Similarly, vitamin B12 is an important vitamin in producing brain health and can show depletion when excluding animal products (Sakkas et al., 2020; Frazier et al., 2021). Despite this, there are many plant-based products that have been fortified with B12 and supplements that are recommended by many doctors to hit

intake needs (Sakkas et al., 2020; Frazier et al., 2021; Shaw et al., 2022). Additionally, iron and zinc are nutrients that vegans need to be aware of when thinking about nutrient goals (Frazier et al., 2021). However, the knowledge of possible deficiencies and the availability of products allows for a vegan diet to be followed with minimized risks.

In fact, a well-planned vegan diet is the helpful to reaching all goals in health, performance, and diet (Shaw et al., 2022; Tambalis, 2022). By being aware of all possible deficiencies, vegans can fuel performance and general health adequately. Due to low availability of micro- and macro- nutrients in plant foods, energy and time need to be contributed towards planning and implementing a balanced vegan diet that hits all dietary needs (Shaw, 2022). If done correctly, a vegan diet can promote an 80% decrease in chances of premature death from cardiovascular disease, diabetes, some cancers, and other common killer diseases of Americans (Shaw et al., 2022; Boutros et al., 2020). Thus, with proper planning and consumption, a vegan diet has underlying benefits to those who choose to follow it.

Effects on Athletics

There are some proven benefits to physical performance resulting from a vegan diet. In a study conducted by Wojciech Krol, he and his colleagues (2020) concluded that vegans had a heart that was correlated more with an endurance athlete than that of the control groups, meaning a vegan diet may prove beneficial to athletes of a primarily endurance-based sport, such as running or swimming. Krol and his colleagues (2020) also determined that there was no major difference between power outputs of the vegans and omnivores. This presents evidence that a vegan diet can improve or maintain physical performance. Additionally, it has been put forth that there are significantly higher VO2 maxes and "better submaximal endurance performance" in vegans than in omnivores (Boutros et al., 2020, p. 1553). This is likely a result of the high carbohydrate intake of many vegan diets.

Additionally, vegan products have presented benefits to recovery times (Frazier et al., 2021; Nacelrio et al., 2020). When compared to maltodextrin post-workout consumption, a protein-vegan multi-ingredient post-workout snack provokes faster recovery times when ingested after resistance training (Nacelrio et al., 2020). Scott Jurek, a professional ultramarathon runner, displays the expedited recovery when following a vegan diet. As an ultramara-thoner, he needs to recover quickly after running 100 miles or more in a singular race, especially when taking on the task of setting a world record in time to complete the whole Appalachian Trail, which stretches for 2200 miles (Frazier et al., 2021). This endeavor required Jurek to run two marathons a day over rough terrain and high elevation for 46 days straight. He credits a lot of his success to his ability to recover quickly (Frazier et al., 2021). His high carbohydrate, plant-based diet allowed him to rebound quickly and continue his trek (Frazier et al., 2021).

Female Athletes

However, if the diet is not followed with attention to deficiencies, the diet will pose risks to the athlete. Female athletes, specifically adolescents, who do not obtain adequate nutrient intakes are more likely to suffer from menstrual irregu-larities, injuries, and low energy (Tambalis, 2022; Gastrich et al., 2020; Mehta et al., 2018). This is often called the "female athlete triad" (Mehta et al., 2018).

The female athlete triad is composed of low energy availability, which leads to menstrual irregularities and low bone mineral density (Mehta et al., 2018). This is very common in adolescents because of the frequency of eating disorders or other forms of food restriction. If a vegan diet is not planned well, it is easy to have suboptimal energy intake because of the low-calorie density of many plant-based foods (Shaw et al., 2022). The presence of this triad presents increased risks for injuries and decreased physical and mental performance (Mehta et al., 2018).

There are other deficiencies that are associated with female athletes, such as calcium, vitamin D, and iron (Gastrich et al., 2020). There are some commonalities between deficiencies of females and vegans, and therefore, must be especially focused on in vegan female athletes (Gastrich et al., 2022; Frazier et al., 2021).

Effects On Academics

Veganism presents some possible benefits to academic performance though not as thoroughly researched as vegan effects on athletic performance. Adam Drewnowski (2019) verbalizes that nutrient-rich diets, good mental health, and adequate sleep attributes to productivity in the workplace. He calls upon reports and congressional testimonies to present that schools offering nutrient-dense meals to students saw improvements in school performance (2019). Sehrish Naveed et al. (2020) pulls on these ideas when establishing that a "healthy diet, physically active lifestyle, and adequate levels of sleep would provide optimal circumstances for brain development and learning during childhood and adolescence," (p. 11). Similar ideas were presented in the cluster analysis done on Australian school children by Dorothea Dumuid and her colleagues (2017). They concluded that all these factors play a role in academic performance to an extent (2017). However, Naveed et al. (2020) places special emphasis on diet quality as they present it as the foundation of all factors effecting cognitive function.

It has been proven that diet has effects on sleep quality (Naveed et al., 2020; St-Onge et al., 2016; Sengul, 2022). Specifically, higher intakes of fruits, vegetables, whole grains, and vegetable oils- all of which prevalent in a vegan diet- can improve sleep quality (St-Onge et al., 2016). Diet has benefits to sleep duration, quality, and latency, and therefore can provide benefits to overall sleep (Sengul, 2022). In result, memory and cognitive function can improve, leading to improved performance in academics (Naveed et al., 2020; Sengul, 2022).

Design and Methodology

Study Design

This study explores both correlation and causation of a vegan diet regarding athletic and academic performance. This is valuable as both academics and athletics are valued by the population evaluated- female high school athletes. By providing data, this study presents possible benefits or harms to this population adopting a vegan diet.

A two-part, convergent design was implemented for this study. The choice of triangulation allowed for both qualitative and quantitative data to be collected. The two methods chosen were a correlational analysis and a design-based case study (DBCS). The combination of these two methods allowed for correlation and causation to be evaluated, presenting any effect veganism had on athletic and academic performance.

The data for the correlational analysis was gathered through a survey, whereas the DBCS followed eleven competitive female high school athletes through a two-week before period, a three-week during period, and a one-week after period of a vegan intervention. At the end of every week, participants completed a survey; the data collected demonstrated changes, or lack thereof, throughout the entire data collection period. The use of data collection during contrasting periods such as these is present in other research projects (Martin et al., 2011; St-Onge et al., 2016).

Some pre-existing research utilized correlational surveys or diet interventions, but none were found that combined a correlational analysis and a DBCS (Martin et al., 2011). By combining methods, a methodology gap was addressed and both correlation and causation were examined.

Subjects

The subjects consisted of any competitive female high school athletes in the Hillsborough County area. A competitive athlete was defined as someone who trained four or more times a week for their respective sport. The correlational analysis survey was advertised on social media and sent out to athletes from various coaches and administrators from schools in Hillsborough County that were emailed the link. Any competitive female high school athletes living in Hillsborough County were permitted to take the survey.

For the DBCS, only omnivorous competitive female high school athletes were chosen to allow for a baseline to be referred to after the vegan intervention. The omnivorous status of participants was crucial to providing data regarding the effects of adopting a vegan diet. Subjects were compiled through advertising on social media and recruitment through schools. Girls' varsity coaches from eight public high schools were emailed to disperse the prospective survey to their athletes. Because all subjects were minors, participants and their legal guardians completed consent forms prior to the start of their participation. Coaches of participants also completed consent forms if applicable. All were informed of aims and details of the DBCS before signing.

Instruments

There was one survey used for correlational analysis. It began with questions adapted from the 14-point Mediterranean Diet Adherence Screener (MEDAS). Inspired by MEDAS, these questions allowed the determination of the dietary status of participants. The survey also asked about performance in school, athletics, sleep, and recovery. All allowed for correlations to be recognized between diet and factors listed above. Answer choices were based on a Likert scale. A basic synopsis of the questions is pictured in Figure 2 and the full survey is attached as Appendix A.

Do you give your consent for your survey answers to be used for research purposes?
Does your parent/legal guardian give consent for your survey answers to be used for research purposes?
Grade
Gender
Do you live in Hillsborough County in Florida?
Are you on a competitive athletic team?
Indicate the frequency you eat these items per week on average.
 Vegetables
 Fruit
 Red Meat
 Poultry
 Dairy Products
 Fish/Seafood
 Eggs
 Processed Foods
How would you describe your dietary preferences?
Indicate frequency of meeting your daily dietetic needs on average.
How much time do you spend planning your meals/snacks?
What sport(s) do you play?
Indicate your frequency of training per week on average.
What is the majority of your training?
How would you describe your energy levels?
How often do you feel adequately fueled for your training on average?
How confident are you in your athletic abilities?
What is your unweighted GPA?
What is your weighted GPA?
SAT/ACT score (format: SAT-; ACT-)
How many honors classes are you taking?
How many AP classes are you taking?
How many dual enrollment classes are you taking?
How confident are you in your school performance?
How many hours of sleep do you get per night on average?

Figure 2. Survey Questions for Correlational Analysis. Answer choices are not included in this figure (see Appendix A).

Six surveys were used in the DBCS. Participants of the case study were required to take two variations of a pre-survey (Appendix B and C), and three variations of a during survey (Appendix D, E, and F) and a post- intervention survey (Appendix G). A basic list of questions used across all surveys are pictured in Figure 3 below. The pre-surveys had questions inspired by MEDAS and questioned academic and athletic performance, sleep, energy levels, and recovery. The during and post- surveys had similar contents with a few differences in the diet section and added reflection questions. Answer choices reflected the Likert scale. All six surveys focused on an individual week of the case study.

Name
Grade
Indicate the frequency you eat these items per week on average.
  Vegetables
  Fruit
  Red Meat
  Poultry
  Dairy Products
  Fish/Seafood
  Eggs
  Processed Foods
Indicate frequency of meeting your daily dietetic needs.
How much time do you spend planning your meals/snacks?
Describe your average diet (meals, snacks, etc.) this past week.
What sport(s) do you play?
Indicate your frequency of training this week.
What is the majority of your training?
How would you describe your energy levels?
How well do you recover from physical activity?
How often do you feel adequately fueled for your training?
How confident are you in your athletic abilities?
Describe your athletic performance this week. (i.e., anything exceptionally good or bad, how you felt about your performance, any other factors that could have affected your athletic performance this past week, etc.)
What are your unweighted and weighted GPAs?
List your current class schedule.
How confident are you in your school performance?
List grades for test, quizzes, and assignments done this week.
How many hours of sleep do you get per night on average?
Describe your overall academic performance this week. (i.e., anything exceptionally good or bad, how you felt about your academic performance, any factors that could have affected your academic performance this week, etc.)
Describe all changes, if any, you have felt from before going vegan to this week. Include any changes in academic and athletic performance, meeting nutrient needs, sleep, energy and recovery levels, stress, or anything else you feel should be noted.
Reflect on your experience going vegan. Go as in-depth as possible and explain any changes you felt in academic performance, athletic performance, energy levels, or anything else that changed.
Reflect on your experience going vegan. Go as in-depth as possible and explain any changes you felt in academic performance, athletic performance, energy levels, or anything else that changed.
Are you going to continue being vegan? Explain.
Are you going to eat more plant-based than before you went vegan? Explain.

Figure 3. Questions From All DBCS Surveys**.** Answer choices are not included in this figure (see Appendices B, C, D, E, F, G).

Participants of the DBCS were supplied with resources to assist them in during the vegan intervention. Although participants were not forced to follow the guidelines seen in these resources, it was given to encourage planning the vegan diet to address possible deficiencies and lessen possible dangers. All instruments were approved by an Institutional Review Board.

Procedures

Once the correlational analysis survey was created, it was broadcasted to high schoolers in Hillsborough County. Emails were sent to coaches and administrators to forward the survey to their athletes and students. The survey was also advertised on social media. After 100 submissions were collected, the correlation coefficient formula was used to calculate correlations between diet and the other factors questioned. Any answers from participants that did not meet criteria (female, Hillsborough County resident, high school athlete) were excluded.

After the compilation of resources and creation of all surveys, the search for participants of the DBCS began. A prospective survey (Appendix H) was created and broadcasted to female high schoolers in Hillsborough County. It was posted on social media and sent to coaches from eight Hillsborough County schools to forward to their athletes. After a week, a pool of eleven subjects was determined, and they were sent the resources and expectations of the study. At this point, all consent forms had been completed and received.

Then marked the beginning of the two-week pre-intervention period. They were instructed to continue their typical week; they ate their habitual diet, trained per usual, and did their typical schoolwork. The pre- survey was completed at the end of both weeks.

After a three-week hiatus of data collection due to holiday breaks, subjects then began the three-week vegan period. All resources (websites, grocery lists, recipes) were given to the participants before the first day of this period. Participants took the during-intervention survey at the end of each week. They reflected on training, schoolwork, energy levels, recovery, and any changes they felt from the before period.

Once the three-week vegan period concluded, the participants were able to return to their choice of diet. Data was collected through the post-intervention survey for the week directly following the vegan period. They were asked comparable questions to the other surveys and completed final reflections. They also indicated whether they would continue the diet or eat more plant-based than they did prior to their participation.

Upon completion of the data collection, data from all six surveys were analyzed. Data was averaged from each period to provide general results regarding changes because of a vegan diet. Additionally, data was followed from each survey for every participant to understand any specific changes a single participant acknowledged.

Limitations

There were limitations acknowledged while conducting this study. To begin, the participant group was small for the DBCS. It was difficult to find female high school athletes who were willing to go vegan. Additionally, many participants attended the same school and participated in the same sports. This limits the scope and validity of the results from the case study.

There was also a three-week gap between the before and during periods because of school break for the holidays; data could not be collected over this time because subjects were not in school or training normally and therefore the data would not be as accurate. This was not ideal because factors could have changed over this hiatus from data collection, but it was unavoidable to collect accurate and comparable data to the pre- and post- periods.

The approach to the case study also presented a limitation. With fears of inviting disordered eating and hyper fixation on nutrients or calories, participants were not required to track their food. This meant the adherence to the diet was based on merit and deficiencies or lack thereof were not able to be recognized when analyzing data. However, it was felt necessary because existing research presented direct and indirect relations of food tracking and eating

disorders, especially when examining female adolescents (McCaig et al., 2020; Embacher Martin et al., 2018). Thus, there was a question included on the during surveys asking participants if they ate anything not vegan throughout the week. If they answered "yes", the were then asked to explain what it was and how often it was eaten. Participants were given no more than two non-vegan foods per week due the highly restrictive attribute of the diet and the limited experience of participants. These answers were considered when analyzing the data.

When looking at the correlational analysis, only four out of the seventy-one useable responses were from someone who followed a vegan diet. This provided limited amounts of data from a vegan viewpoint and thus, the correlational coefficients analyzed could differ from ones calculated from data with more vegan participants. However, this was not a factor that could have been controlled.

Delimitations

The limited scope of subjects and variables tested presented delimitations. First, subjects were only pooled from high schools in Hillsborough County. Subjects were also only female competitive athletes, not acknowledging other genders or populations. Secondly, other factors that could affect results were not focused on (i.e., strength versus endurance athletes, the amount of plant foods needed to see effects, and on-season or off-season periods). The lack of data regarding these parameters calls for further research.

Results and Analysis

Correlational Analysis

The correlational survey was completed by 100 people, but only 71 responses were usable as they fitted the needed demographic. Therefore, all results from the correlational analysis were based on those 71 responses.

For the sake of analysis, all answer choices for survey questions were changed to a scale from 0-5. The assignments of numerical values for each answer are depicted in Table 1 below. Survey participants did not see the numbers, but instead the qualitative answer choices; numbers were assigned after all the responses were collected. By converting all characteristic data to numbers, Pearson correlational coefficients could be calculated and any correlation between diet and various factors could be reported.

Table 1. Numerical Assignments to Characteristic Data Collected from Surveys

0	1	2	3	4	5
Vegan	Vegetarian	Pescetarian	Omni (LAP)	Omni (HAP)	
	Almost never	Rarely	Sometimes	Often	Almost everyday
	Almost never	Rarely	Sometimes	Often	Always
	Very low	Low	Average	High	Very high
	Very poorly	Poorly	Average	Well	Very well
	Not at all confident	Unconfident	Average	Confident	Very confident

"HAP represents high animal product, whereas "LAP" represents low animal product.

Correlation to Athletics

There were four main factors used to determine effects on athletic performance: energy levels, how often participants felt adequately fueled for training, recovery levels, and athletic confidence. All 71 respondents completed questions about these factors; the answers were analyzed with the Pearson correlation coefficient formula. The resulting r values are listed in Table 2 below. The r values were then analyzed with alpha level .05 to determine p value and statistical significance.

Table 2. Correlation Between Diet and Factors of Athletic Performance

	GPA	Testing Confidence	Ability to accomplish schoolwork	Academic confidence
Pearson's r *value*	.0077	-.023	-.056	-.096

Note. Data is reported with two significant figures.

It is shown that feeling fueled for training, recovery levels, and athletic confidence had a weak negative correlation with animal products, meaning people who ate less animal products had better experiences regarding these factors. However, all p values determined that this data was not statistically significant. There was also a weak positive correlation with increased animal products and energy levels, but was deemed statistically insignificant, $r(69) = .0077$, $p = .95$. Therefore, this data fails to reject the null hypothesis, and it can be concluded from this data that veganism does not have a correlation with athletic performance.

Correlation to Academics

The same method of analysis used for determining correlation to athletics was used for academics. There were four factors questioned used to determine academic performance: grade point average (GPA), testing confidence, ability to accomplish all schoolwork, and overall academic confidence. The r values resulting from the correlational analysis of these factors and diet are reported in Table 3.

Table 3. Correlation Between Diet and Factors of Academic Performance

	GPA	Testing Confidence	Ability to accomplish schoolwork	Academic confidence
Pearson's r *value*	0	-.10	-.16	-.042

Note. All data is reported with two significant figures.

The greatest correlation was seen in ability to accomplish schoolwork, showing a weak negative correlation with consumption of animal products, yet it was not statistically significant, $r(69) = -.16$, $p = .18$. All other factors showed weak or no correlation with animal product consumption and were also statistically insignificant when examining p values. Once again, the data fails to reject the null hypothesis, and the data implies no correlation between veganism and academic performance.

Design Based Case Study

There were eleven participants in the DBCS. Qualitative and quantitative data was collected from six surveys completed over six weeks. Numbers were assigned to some answers using the same key seen in Table 1. Then, the means and standard deviations of the data were calculated to provide quantitative data. The answers to the free response questions were analyzed to provide qualitative data.

Quantitative Data

Participants of the DBCS were asked various questions and chose answers based on the Likert scale. The answers were changed to numerical values to calculate mean. The answers of weeks 1-2 were averaged, and the same for weeks 3-5 for each participant. Then those averages were combined with the averages of all other participants to find the average across all participants (Table 4). The weeks 1-2 mean was then subtracted from the weeks 3-5 mean of each participant to pinpoint any changes that occurred; the differences were averaged across all participants to find average difference between periods. Lastly, standard deviation from the mean difference was calculated.

Table 4. Means and Standard Deviation Calculated from Data of DBCS Participants

	Meeting caloric needs	Meeting nutrient needs	Energy levels	Adequately fueled for training	Recovery levels	Athletic confidence	Academic confidence
Wks. 1-2 mean	3.86	3.59	2.86	3.50	3.73	3.96	3.86
Wks. 3-5 mean	3.86	4.21	3.40	3.67	3.70	3.88	4.13
Mean difference between periods	0.42	0.61	0.53	0.50	0	-0.08	0.29
Standard deviation from mean difference	0.86	1.03	0.75	1.10	0.81	0.34	0.63

Note. Mean differences listed will not be equivalent to the difference of the mean values listed because difference was averaged from each individual of the original data.

All factors, except recovery levels and athletic confidence, showed a positive difference between periods, implying that going vegan had a positive effect. The greatest overall change was in meeting nutrient goals, with a 0.61 difference and a standard deviation of 1.03. The least amount of change was recovery levels, with zero difference; the only negative value was in athletic confidence, though very small at -0.08. This suggests that veganism caused positive effects on meeting caloric and nutrient needs, energy levels, fueling for training, and academic confidence. However, the standard deviation values a relatively large regarding the data, implying that the variability of the results is significant. Thus, it can be inferred that going vegan improved general health and academic and athletic performance, but the qualitative data is necessary to provide fully accurate and reliable data.

Qualitative Data

There were free response questions on each survey, asking participants to describe how they felt about their athletic and academic performance and overall thoughts of each week. Any answers that stood out were marked for analysis. For the sake of reporting, participants will be named with "P" and their number (i.e., P1).

Seven participants said they felt "lighter", "cleaner", "less sick", or "less bloated" in some way. P10 elaborated when saying they "never felt too full/sick in training." P6 and P7 also hit a personal record in their respective training on the first week of going vegan.

Every participant talked about their energy levels. Many wrote they "felt more energized" in the first week but began to feel tired in the second. Six people verbalized they felt more energized in the morning yet became very

tired in the afternoon; by the time they got to the evening, all they wanted to do was sleep. This most likely correlates to the pattern of better sleep seen throughout the data; five participants shared they fell asleep easier and felt more rested when they woke up.

There were mixed responses when it came to training. P4 said "the sets seem harder than usual, and I don't feel I'm recovering as fast afterwards," and "I just felt more tired and pain like lactic acid during swim than usual." Similarly, P10 said she "felt [her] muscles were sorer,"; however, she also said her energy was high after she finished her runs. On the other hand, P6 said "I have genuinely seen improvement in how I feel during and after exercise that I think is correlated to the veganism." P1 also said she felt energized throughout the duration of her workouts and "could go for a little extra time than normal."

There were not significant changes reported in academic performance, with most participants writing "average", "usual", "normal", or "nothing changed." However, P5, P7, and P11 said their motivation and focus improved. P5 elaborated, saying she was more diligent and met due dates better than before she went vegan. P1 also said she was "retaining information better."

Despite the mixed responses, ten participants said they were going to eat more plant-based than they did before. Of those ten, nine of them supported their decision to eat more vegan foods by saying they "felt better", "cleaner", or "more energized."

Discussion

Based on results from the correlational analysis and DBCS, it has been concluded that veganism elicits slightly positive, but varying effects on athletic and academic performance.

Fulfillment of the Gap

Throughout this study, multiple gaps in existing research have been filled. There was no previous research regarding the effects of veganism on athletic and academic performance. This study showed that there is little effect on performance, filling an empirical gap. Additionally, this had not been previously tested with competitive female high school athletes, addressing a demographic gap. Lastly, a methodology gap was filled by combining a correlational analysis and DBCS. The correlational analysis showed that any correlation was not statistically significant, uniformly failing to reject the null hypothesis. The DBCS presented varying results, with some participants seeing benefits while others did not; this implies that there are multiple factors that could contribute to the effects of diet on athletic and academic performance. However, most had a positive experience as seen by their desire to eat more plant-based than prior to their participation. Thus, the scope, method, and findings filled gaps present before this study.

Implications

This study sought to examine the effects of veganism on the athletic and academic performance in competitive female high school athletes. The data presented no correlation between diet and performance, but slight effects caused by going vegan as seen in the DBCS. More research would be helpful in finding implications, but this study shows that it may be beneficial to some people. The DBCS presented that veganism helped with some participants' energy, recovery, motivation, focus, sleep, and improved their ability to meet daily nutrient and calorie needs. This varied from participant to participant, but almost all said they enjoyed it and would eat more plant-based than before trying veganism. Additionally, any negative changes were less significant than the positives, suggesting veganism might have a slightly positive or no effect on academic and athletic performance. This data implies it could be helpful for female high school athletes to go vegan for a short period of time and record any changes they felt, showing whether veganism would be beneficial to them. They would exit the vegan period with better knowledge of what foods or diets their

body prefers and can help them maximize their athletic and academic performance. Additionally, it might be advantageous to increase the abundance of plant-based foods in a person's diet. Although they would not be vegan, the increased consumption of plant foods might provide benefits.

Limitations

As noted previously, multiple limitations were presented in this study. The first was a small group of participants in the DBCS; a larger sample size would provide more accurate and representative data. Similarly, only four of the 71 survey respondents were vegan. This could affect the r values because not as much data was provided from vegan female high school athletes.

Additionally, the timing of the DBCS was not ideal. A three-week period in between the pre- and during periods of the DBCS could have affected results, yet it was unavoidable. Likewise, having only a two-week pre period and a three-week during period could have affected the means seen in Table 4 as the amount of time for each period was not equivalent. Furthermore, three weeks for a diet change is not ideal to fully test the effects. Other studies found that conducted diet interventions ranged from two months to two years (Martin et al., 2011; Meslier et al., 2020). However, time constraints did not allow for an extended diet change, so the results of the DBCS could not signify the effects of longer-term veganism.

Another limitation presents itself when examining other factors contributing to athletic and academic performance, not all of which could be controlled. For example, sleep and course load were considered when analyzing effects on academic performance, but there could be other influential factors.

The decision to allow two instances of eating a non-vegan food per week and basing adherence on merit also created a limitation. This could have hampered the results but felt necessary as a restrictive diet such as veganism, especially for people who are new to the diet, is very difficult to follow perfectly and could encourage disordered eating habits (McCaig et al., 2020; Embacher Martin et al., 2018).

Areas for Future Research

Replication of the Current Study

To replicate the current study and validate the findings, the survey used for the correlational analysis should be distributed to competitive female high school athletes and the answers should be analyzed with the Pearson correlation coefficient. Additionally, a group of female high school athletes should be gathered to conduct the DBCS. The weekly surveys should be distributed to this group as they undergo each period; all surveys are included in the appendices. Analysis of the data should include calculating means and standard deviations in addition to highlighting any qualitative answers that stand out. A diverse group of DBCS participants and correlational survey respondents should be sought to propose the most representative data.

Different Directions

There are various directions this research could follow. To begin, a different demographic could be evaluated. This could include different ages, genders, or geographic locations. Additionally, the scope could narrow, possibly focusing on specific sports instead of general athletes. This could eliminate some of the variation seen in the DBCS results. Furthermore, a qualitative interview with DBCS participants following the vegan period could provide more in-depth data to better understand the effects of veganism. Finally, the effects of various types of plant-based diets (vegetarian, vegan, raw vegan, etc.) could be examined, developing a better understanding of the abundance of plant foods needed

in a person's diet to experience similar effects. All these directions could lead to more representative and accurate data filling other empirical gaps regarding the effects of veganism in the modern world.

References

Boutros, G. H., Landry-Duval, M.-A., Garzon, M., & Karelis, A. D. (2020). Is a vegan diet detrimental to endurance and muscle strength? *European Journal of Clinical Nutrition*, *74*. https://doi.org/10.1038/s41430-020-0639-y

Drewnowski, A. (2019). Impact of nutrition interventions and dietary nutrient density on productivity in the workplace. Nutrition Reviews, 78(3), 215–224. https://doi.org/10.1093/nutrit/nuz088

Dumuid, D., Olds, T., Martín-Fernández, J.-A., Lewis, L. K., Cassidy, L., & Maher, C. (2017). Academic Performance and Lifestyle Behaviors in Australian School Children: A Cluster Analysis. Health Education & Behavior, 44(6), 918–927. https://www.jstor.org/stable/48591487

Embacher Martin, K., McGloin, R., & Atkin, D. (2018). Body dissatisfaction, neuroticism, and female sex as predictors of calorie-tracking app use amongst college students. *Journal of American College Health*, *66*(7), 608–616. https://doi.org/10.1080/07448481.2018.1431905

Frazier, M., Cheeke, R., & Holtzman, R. (2021). *The Plant-Based Athlete: A Game-Changing Approach to Peak Performance*. HarperOne, An Imprint of HarperCollins publishers.

Gastrich, M. D., Quick, V., Bachmann, G., & Moriarty, A. M. (2020). Nutritional risks among female athletes. Journal of Women's Health, 29(5), 693-702.

Król, W., Price, S., Śliż, D., Parol, D., Konopka, M., Mamcarz, A., Wełnicki, M., & Braksator, W. (2020). A Vegan Athlete's Heart—Is It Different? Morphology and Function in Echocardiography. *Diagnostics*, *10*(7), 477. https://doi.org/10.3390/diagnostics10070477

Martin, C. K., Rosenbaum, D., Han, H., Geiselman, P. J., Wyatt, H. R., Hill, J. O., Brill, C., Bailer, B., Miller-III, B. V., Stein, R., Klein, S., & Foster, G. D. (2011). Change in Food Cravings, Food Preferences, and Appetite During a Low-Carbohydrate and Low-Fat Diet. *Obesity*, *19*(10), 1963–1970. https://doi.org/10.1038/oby.2011.62

McCaig, D., Elliott, M. T., Prnjak, K., Walasek, L., & Meyer, C. (2020). Engagement with MyFitnessPal in eating disorders: Qualitative insights from online forums. *International Journal of Eating Disorders*, *53*(3), 404–411. https://doi.org/10.1002/eat.23205

Mehta, J., Thompson, B., & Kling, J. M. (2018). The female athlete triad: It takes a team. *Cleve Clin J Med*, *85*(4), 313-320.

Meslier, V., Laiola, M., Roager, H. M., De Filippis, F., Roume, H., Quinquis, B., Giacco, R., Mennella, I., Ferracane, R., Pons, N., Pasolli, E., Rivellese, A., Dragsted, L. O., Vitaglione, P., Ehrlich, S. D., & Ercolini, D. (2020). Mediterranean diet intervention in overweight and obese subjects lowers plasma cholesterol and causes changes in the gut microbiome and metabolome independently of energy intake. *Gut*, *69*(7), 1258–1268. https://doi.org/10.1136/gutjnl-2019-320438

Naclerio, F., Seijo, M., Earnest, C. P., Puente-Fernández, J., & Larumbe-Zabala, E. (2020). Ingesting a Post-Workout Vegan-Protein Multi-Ingredient Expedites Recovery after Resistance Training in Trained Young Males. *Journal of Dietary Supplements*, 1–16. https://doi.org/10.1080/19390211.2020.1832640

Naveed, S., Lakka, T., & Haapala, E. A. (2020). An overview on the associations between health behaviors and brain health in children and adolescents with special reference to diet quality. International Journal of Environmental Research and Public Health, 17(3), 953.

Pareek, P., & Ayesha, S. (2015). Physical and academic performance of vegetarian and non-vegetarian school girls (13–15 yrs). Advanced Studies in Biology, 7, 79–88. https://doi.org/10.12988/asb.2015.41165

Rogerson, D. (2017). Vegan diets: practical advice for athletes and exercisers. Journal of the International Society of Sports Nutrition, 14(1), 36.

Sakkas, H., Bozidis, P., Touzios, C., Kolios, D., Athanasiou, G., Athanasopoulou, E., Gerou, I., & Gartzonika, C. (2020). Nutritional Status and the Influence of the Vegan Diet on the Gut Microbiota and Human Health. Medicina, 56(2). https://doi.org/10.3390/medicina56020088

Sengul, P. (2022). Comparison of Vegan and Non-Vegan Diets on Memory and Sleep Quality. Clinical Nutrition Open Science. https://doi.org/10.1016/j.nutos.2022.05.005

Shaw, K. A., Zello, G. A., Rodgers, C. D., Warkentin, T. D., Baerwald, A. R., & Chilibeck, P. D. (2022). Benefits of a plant-based diet and considerations for the athlete. European Journal of Applied Physiology, 1-16.

St-Onge, M.-P., Mikic, A., & Pietrolungo, C. E. (2016). Effects of Diet on Sleep Quality. Advances in Nutrition, 7(5), 938–949. https://doi.org/10.3945/an.116.012336

Tambalis, K. D. (2022). Special Nutritional Needs for Athletes and Exercisers. European Journal of Physiotherapy and Rehabilitation Studies, 3(1).

United States Department of Agriculture Economic Research Service. Food Availability and Consumption. (2018). usda.gov. https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/food-availability-and-consumption/