

The Effect of Qualitative Versus Quantitative Nutritional Education on the Eating Habits of Female High School Athletes

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In order to perform well and maintain their health, athletes must ensure proper nutrition. However, female athletes are prone to disordered eating behaviors¹, which put the athletes at risk of acquiring the female athlete triad². Although the effect of nutritional education on collegiate female athletes has been explored, with differing conclusions, the effect of different types of nutritional education on high school athletes has not been investigated. In this study, the eating habits of high school female athletes were compared before and after watching either a quantitative or qualitative nutrition education presentation. The participants were asked to use a smartphone app to track the amount of each food group they consumed over two weeks. These reported amounts were then analyzed using nutritional guidelines set by the Automated Self-Administered 24-Hour Recall (ASA24) to determine the healthiness of participants' eating habits. It was found that the quantitative presentation ($M=-0.26$, $SD=0.97$) did not have a significant effect on eating habits; $t(17)=-1.13$, $p=0.86$. The qualitative presentation ($M=-0.21$, $SD=0.82$) did not have a significant effect either; $t(18)=-1.12$, $p=0.86$. It was additionally found that the participants' eating habits largely failed to meet nutritional guidelines. These results suggest that high school female athletes do not practice proper nutrition and are generally unaffected by nutritional education, putting them at risk for the female athlete triad. By garnering a greater knowledge of how female athletes practice nutrition and are impacted by nutritional education, the medical and sports communities can implement strategies to improve athlete health.

Introduction

Nutrition is an important aspect of health, especially for female athletes. The female athlete triad is a syndrome that occurs in female athletes who do not practice proper nutrition¹. According to Jennifer Day et al. (2015), the three parts of the triad are osteoporosis, low energy availability, and menstrual dysfunction. Female athletes are particularly prone to eating disorders as a result of distorted body image and weight concern. *Anorexia athletica* is an eating disorder specific to athletes and is often accompanied by competitiveness and compulsiveness. However, many female athletes simply demonstrate disordered eating, which often consists of over-exercise¹. Disordered eating results in low energy availability. This energy imbalance, along with stress hormones, can cause a dysfunction in the endocrine system. In turn, this causes amenorrhea, the absence of a menstrual period, and a decrease in estrogen production. A lack of estrogen can then lead to osteoporosis². A study in 2003 found that improper nutrition is associated with fatigue and a decrease in athletic performance as well¹⁵.

In female collegiate athletes and students, a need for nutritional education has been found. The need was demonstrated by a hypo-energetic diet in participants in one study¹¹ and by low scores on a nutritional test in others^{3,13}. Previous research on the nutritional knowledge of female athletes has found varying conclusions on the relationship between nutritional knowledge and athletes' eating habits. In 2019, Condo et al. assessed the nutritional knowledge and intake of female Australian rules football players. They found that the athletes' knowledge and intake were lacking, particularly in the topics of carbohydrates and micronutrients. In 2015, a study by Jennifer Day et al. revealed similar results, as the participants' mean energy availability was 30.8 kcal/kg of fat-free mass per day, which is more than 10 kcal/kg of fat-free mass per day under the suggested amount.

However, the study also concluded that although nutritional education increased nutritional knowledge, it did not significantly impact caloric intake. On the other hand, Condo et al.² claimed that nutritional education correlates with healthy eating habits because participants in their study who demonstrated low nutritional knowledge when taking a questionnaire also demonstrated an inadequate dietary intake when tracking their intake with an Automated Self-Administered 24-Hour Recall (ASA24). Although it is generally believed that the more knowledge an athlete has about her nutrition, the healthier she will be; multiple studies have found that the use of fitness-tracking apps contributes to eating disorders^{6,12}. The author of *The New Power Eating* warns against calorie counting, as it often leads to caloric restriction⁷. These findings suggest that the specificity and content of one's nutritional knowledge has an impact. Few studies have investigated the impact of nutritional education on high school female athletes, and fewer still have investigated the effectiveness of specific types of nutritional education.

The purpose of this project was to determine whether a qualitative or quantitative nutritional education format would have a greater positive impact on the eating habits of high school female athletes. If the effectiveness of different types of nutritional education on female athletes is determined, the knowledge gained can be used by coaches and physical trainers to provide resources to athletes that can best prevent the negative impacts of improper nutrition. It was hypothesized that qualitative nutritional education would result in high school female athletes meeting a greater number of national serving size guidelines than a quantitative nutritional education. The quantitative education included a focus on calorie consumption, and calorie counting has been found to increase the risk of under-eating. Therefore, that aspect of the quantitative education would reduce its overall effectiveness. In this study, the effects of a qualitative and quantitative nutritional education course on nutrition for female athletes were compared against each other. Start Simple with MyPlate, a smartphone application developed by the United States Department of Agriculture, was used by participants in this study to track their intake of grain, protein, dairy, fruit, and vegetables in cups throughout the day for four days over two weeks. The first week, the participants had no nutritional education, and the second week one group of participants watched a quantitative presentation on nutrition and the other group watched a qualitative presentation on nutrition. The differences in participants' eating habits between the two weeks were compared to determine which presentation was more effective.

Methods

A total of 44 high school female athletes from the same school were recruited to participate by sending emails to all of the female athletes listed on the sports team rosters found on the school website. These participants were split evenly into Group One and Group Two. All participants were asked to use the app Start Simple with MyPlate on the Tuesdays and Fridays of two weeks. The app allowed the user to set and check off goals related to each of the five food groups. Participants were asked to set and check off a goal for each cup of food or drink they consumed that fell under each food group and submit a screenshot of their goals to a Google Form (see Figure A1 for a submission sample). The participants were

given no education the first week to serve as a control. Over the weekend between the two weeks, participants in Group One were asked to watch a quantitative presentation on nutrition, and participants in Group Two were asked to watch a qualitative presentation on nutrition (Figure 1). The courses were made up of two Google Slide presentations that each contained seven subsections with nutritional information (see Figures A2 and A3 for the presentations). The qualitative presentation had subsections “Home vs. restaurant” and “Whole vs. processed,” whereas the quantitative presentation had subsections “Calories” and “Nutrition labels.” Both presentations had the subsections “Carbohydrates,” “Protein,” “Fats,” “Micronutrients,” and “Hydration.” The main words in each title were briefly defined and then qualitative or quantitative details were added. These two nutrition education presentations contained information from a number of primary and secondary sources. A reference slide was included as well. Quantitative nutritional information was defined as any detail that contained a number with a unit or a percent. Qualitative nutritional information was defined as any detail that included a comparison or standard of nutritional value. The nutritional guidelines for the daily amount of fruits, vegetables, proteins, grains, and dairy for female teenagers from the ASA24 were used to measure the eating habits of the participants. The ASA24 has been used in other studies to evaluate eating habits^{2,3}, and the survey has been described as effective for athlete populations because the ASA24 can measure a change over time and has low chances of affecting the data¹³. The number of nutritional guidelines that were set by the ASA24, out of five, met by all participants for each time they tracked their consumption was recorded. The average change in the number of guidelines met for each participant between the two weeks was calculated and analyzed using a paired *t*-test and an alpha value of 0.05. A code name was generated for each participant by the ASA24 to maintain anonymity.

Figure 1: Experimental design diagram

Title of the Experiment			
The Effect of Qualitative Versus Quantitative Nutrition Education on the Eating Habits of Female High School Athletes			
Hypothesis			
A qualitative nutritional education presentation would result in high school female athletes meeting a higher number of national serving size guidelines than a quantitative nutritional education. The quantitative education included a focus on calorie consumption, and calorie counting has been found to increase the risk of under-eating. Therefore, that aspect of the quantitative education may reduce its overall effectiveness.			
Independent Variable Type of educational presentation			
Levels of Independent Variable	No education	Quantitative education (Group One)	Qualitative education (Group Two)
Number of Repeated Trials	44 athletes	22 athletes	22 athletes
Dependent Variable			
The number of standards participants meet on the Automated Self-Administered 24-Hour Recall (ASA24) out of five. This was measured by participants keeping track of how many cups they consumed of each food group with the smartphone app Start Simple with MyPlate, which includes goals for grains, vegetables, fruits, dairy, and protein.			
Control Group			
The participants during the first week with no educational materials provided			
Constants			
The number of days of tracking for each independent variable, the application used, the duration of each nutrition course, when each course is given, and the gender of participants			

Results

Table 1 shows the raw data for each participant, including which type of presentation they watched as well as the number of nutritional guidelines they met for Tuesday and Friday of each week. Note that some of the participants did not submit a total of four responses. The change in the number of guidelines met between weeks was calculated by subtracting the average number of Week Two guidelines from the average number of Week One guidelines.

Of all the screenshots submitted by participants, the qualitative presentation (M=3.0) resulted in a higher number of guidelines met than the quantitative presentation (M=2.4) and the control before either presentation (M=2.9), as seen in Table 2. Furthermore, the mean of the overall guidelines met was 2.8.

The change in nutritional guidelines met is shown in Figure 2, which depicts the difference for each participant, except those who did not submit a screenshot for Week Two. Most of the participant responses displayed a negative change from Week One to Week Two. A larger number of participants who watched the qualitative presentation showed a positive change than the number of participants who watched the quantitative presentation, meaning the qualitative presentation resulted in improved eating habits more often than the quantitative presentation.

The mean, median, and mode of these changes were then found (Table 3). The mean of the difference of nutritional guidelines met between Week One and Week Two for participants who watched the quantitative presentation had a greater absolute value than that of the participants who watched the qualitative presentation, although both means were negative.

Table 1: Number of nutritional guidelines met by participants in each presentation group

Participant	Type of presentation	Number of Guidelines met			
		Tuesday 1	Friday1	Tuesday 2	Friday 2
QQNPE2006	qualitative	2	2	2	2
QQNPE2044	qualitative	3	5	2	2
QQNPE2034*	quantitative	2	2	3	DNR
QQNPE2023	quantitative	3	3	3	3
QQNPE2020	quantitative	3	4	3	2
QQNPE2018*	qualitative	2	3	DNR	2
QQNPE2043	quantitative	5	5	3	3
QQNPE2030*	quantitative	2	5	4	DNR
QQNPE2022	quantitative	4	4	3	3
QQNPE2002	quantitative	3	5	5	5
QQNPE2048	qualitative	5	5	5	5
QQNPE2038*	quantitative	2	DNR	2	2
QQNPE2005*	quantitative	3	DNR	DNR	3
QQNPE2004*	quantitative	4	5	DNR	4
QQNPE2024	quantitative	4	4	4	4
QQNPE2020*	DNR	4	DNR	DNR	DNR
QQNPE2036	qualitative	4	3	3	3
QQNPE2010*	quantitative	4	DNR	3	3
QQNPE2045	qualitative	3	3	2	2
QQNPE2019	qualitative	2	2	2	2
QQNPE2001	qualitative	1	2	2	2
QQNPE2046	qualitative	2	2	2	3
QQNPE2013*	qualitative	DNR	2	DNR	3
QQNPE2031*	DNR	3	DNR	DNR	DNR
QQNPE2027	qualitative	3	2	3	2
QQNPE2042	quantitative	2	3	3	5
QQNPE2049*	DNR	2	DNR	DNR	DNR
QQNPE2025*	DNR	2	DNR	DNR	DNR
QQNPE2003*	qualitative	DNR	3	4	DNR
QQNPE2050	quantitative	5	3	1	3
QQNPE2055	qualitative	3	2	2	2
QQNPE2051	qualitative	2	2	1	1
QQNPE2060*	DNR	2	DNR	DNR	DNR
QQNPE2057	qualitative	3	2	3	2
QQNPE2059	qualitative	2	2	3	2
QQNPE2058*	quantitative	3	2	DNR	2
QQNPE2052*	quantitative	2	DNR	3	1
QQNPE2056*	DNR	2	2	DNR	DNR
QQNPE2054*	quantitative	2	1	DNR	1
QQNPE2063	qualitative	1	2	2	2
QQNPE2007*	qualitative	DNR	4	2	3
QQNPE2017	qualitative	3	3	2	DNR

This table shows the number of nutritional guidelines met by each participant on the Tuesdays and Fridays of two weeks, as well as which presentation they watched. Note that not every participant submitted a response for all four days, and some did not watch the presentation.

*Participant submitted fewer than four responses

Table 2: Descriptive statistics summary table of number of guidelines met

Statistic	Number of guidelines met			
	Overall	Overall before presentation	After quantitative presentation	After qualitative presentation
\bar{x}	2.8	2.9	2.4	3.0
Standard deviation	2.0	1.0	0.9	1.0
Mode	3.0	2.0	2.0	3.0

This table displays the mean, median, and mode of the nutritional guidelines met by all participants over Week One and Week Two.

Figure 2: Differences in number of guidelines met between each week bar graph. This bar graph depicts the differences in the nutritional guidelines met by participants (Week Two - Week One) who watched either the quantitative or qualitative guidelines met. A negative difference corresponds to fewer nutritional guidelines met.

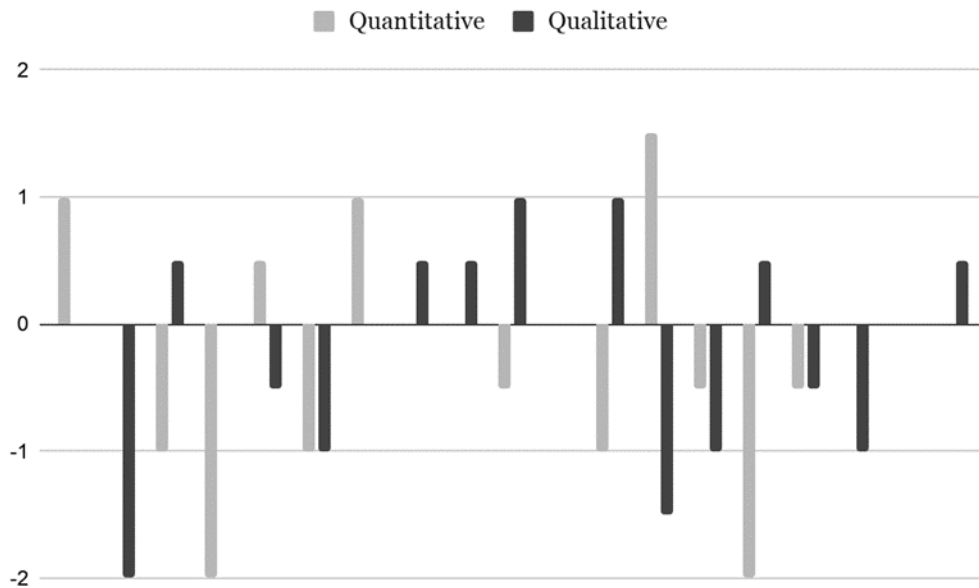


Table 3: Descriptive statistics summary table of difference in number of guidelines met

Statistic	Difference of guidelines met (Week Two - Week One)	
	Quantitative	Qualitative
\bar{x}	-0.3	-0.2
Median	0.0	0.0
Mode	0.0	0.0

The mean, median, and mode of the difference of nutritional guidelines met between Week One and Week Two for the qualitative and quantitative presentation is demonstrated in this table. If participants submitted less than two responses, their data was not included.

A paired-samples *t*-test was conducted at an alpha level of 0.05 to compare the difference in nutritional guidelines met after watching the quantitative presentation and the qualitative presentation. The alpha value used was 0.05. The results, as seen in Table 4, indicate that there was no significance in the differences between guidelines met from Week One to Week Two for the quantitative presentation ($M=-0.26$, $SD=0.97$); $t(17)=-1.13$, $p=0.86$. Likewise, there was not a significance in the difference between guidelines met from Week One to Week Two for the qualitative presentation ($M=-0.21$, $SD=0.82$); $t(18)=-1.12$, $p=0.86$. The critical value for the quantitative presentation was 1.73, and the critical value for the qualitative presentation was 1.75.

Table 4: Inferential statistics t-Test comparing difference of guidelines met (Week Two-Week One) Table 4 shows the t-statistic and p-value for the quantitative and qualitative presentation results, as well as the null hypothesis decision.

Presentation type	<i>n</i>	\bar{x}	σ	<i>t</i>	<i>p</i>	Decision
Quantitative	17	-0.26	0.97	-1.13	0.86	Fail to reject
Qualitative	18	-0.21	0.82	-1.12	0.86	Fail to reject

Discussion

The purpose of this project was to determine whether a qualitative or quantitative nutritional education would have a greater positive impact on the eating habits of high school female athletes. The hypothesis that the qualitative nutritional presentation would have a greater positive impact was not supported because neither the quantitative nor qualitative presentation had a significant impact on the eating habits of the participants.

There was not enough evidence to reject the null hypothesis that watching the nutrition presentations had no or a negative effect on the eating habits of participants. Neither the quantitative presentation ($t(17)=-1.13$, $p>0.05$) nor the qualitative presentation ($t(18)=-1.12$, $p>0.05$) had a significant impact on the eating habits of the participants (See Table 4). This lack of significance suggests that both a quantitative and qualitative perspective on nutrition are needed to affect eating habits, or that nutritional knowledge does not necessarily influence nutrition.

A sample screenshot submitted by Participant QQNPE2051 is shown in Figure A1, and Table 1 contains all of the raw data collected, including each participant, the type of presentation they watched, and the number of nutritional guidelines they met the week before and after watching a nutritional presentation. The mode of two nutritional guidelines met out of five (Table 3) suggests that participants' diets are inadequate. Figure 2 displays the differences between the weeks for each type of presentation. The participants who watched the qualitative presentation had a positive change more frequently, supporting the hypothesis that the qualitative presentation would be more effective than the quantitative. However, the results from both types of presentation are similar enough that the null hypothesis cannot be rejected. This trend is depicted in Table 3 as well since the mean of the change between the two weeks for the quantitative presentation is slightly more negative than the mean of the changes between the two weeks for the qualitative presentation. Since both means in Table 3 are negative, the participants' eating habits met less nutritional guidelines in the second week. The mode of the differences for both presentations is zero, meaning there was no change between the two weeks for most participants. These mean and mode values suggest that overall the presentations had a neutral or negative effect on the eating habits of participants.

Although a negative change was present between Week One and Week Two and participants who watched the qualitative presentation met more guidelines than those who watched the quantitative presentation, neither differences were statistically significant, meaning that neither presentation had a notable effect on the athletes' eating habits. Additionally, few participants met all nutritional guidelines. The participants' diets did not align with the suggested daily nutritional values. These poor eating habits can result in low energy availability, which in turn puts the athletes at risk of developing the female athlete triad. A study done in 2019 acknowledges this high risk for female athletes¹⁴. Instead of educating female athletes, the study evaluated their knowledge of the triad and found that this knowledge was incomplete. Not being fully aware of the consequences of proper eating habits may have been a factor in the participants' low energy intake in the 2019 study. Studies by Condo et al. in 2019 and Day et al. in 2015 garnered similar results when evaluating the diets of female athletes. The participants of both studies were found to be lacking in their daily energy consumption. The dietary choices of professional athletes during a competition were evaluated in a 2019 study¹⁰. They found that the athletes chose foods containing carbohydrates over any other food group. A similar occurrence could have taken place in this study, which could explain the low number of guidelines met since the guidelines covered a variety of food groups. While participants were exposed to nutritional knowledge, they failed to implement that knowledge into their daily consumption habits. The aforementioned study by Day et al. likewise concluded that nutritional knowledge does not impact dietary intake. In contrast, Manore et al.⁷ emphasize the importance of nutritional education for high school athletes, suggesting that this healthful knowledge will help them make more beneficial dietary decisions later in life. A nutritional smartphone application was used by participants to track their eating habits in this current study. In previous studies, correlations between fitness tracking apps and eating disorders have been made^{6,12}. Perhaps the utilization of the application made participants more sensitive to and therefore self-conscious about their eating habits, leading them to practice and report low consumption.

There were some possible sources of error in the experiment. There was a relatively small sample size. Moreover, not all participants submitted screenshots for all four days, and some participants may have not been entirely accurate in their reports. The participants may have not watched the presentation that they were instructed to watch. Additionally, in a 2013 telephone survey of adults in the United States, 63% of respondents who track their health data reported that the tracking has impacted their perspective on health⁴. Therefore, the simple action of participants tracking their intake could have affected their results.

Future research on this topic could explore how including the benefits of healthy eating in nutritional education impacts athletes' eating habits and attitudes toward eating. Studies could try to determine how one's sport, gender, or competitive level impacts their eating habits. Finally, the viewing of nutritional presentations could be compared to other methods of teaching healthy habits, such as being rewarded for healthy behaviors. Further investigations of athlete nutrition and education are essential in developing strategies to improve athletes' health and performance.

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Appendix

Figure A1: Sample submission. This screenshot was submitted by Participant QQNPE2051 on the Tuesday of Week Two. The number in each circle represents the serving(s) of that food group consumed. --- indicated that no servings were consumed.

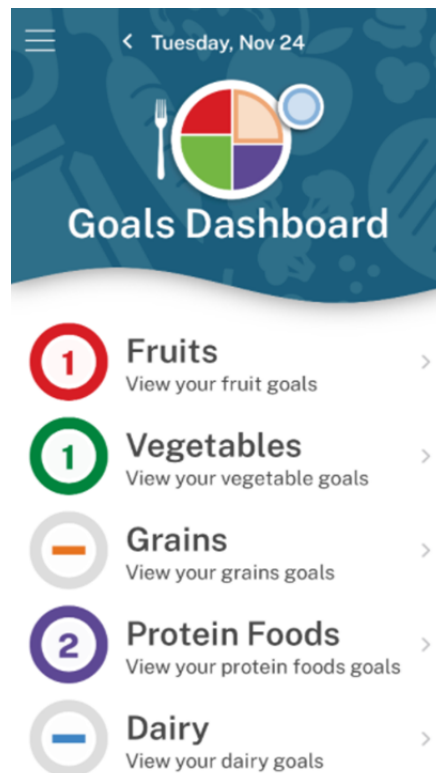


Figure A2: Quantitative presentation

Female Athlete Nutrition Course


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Quantitative Education

Calories

20 calories per pound BW

Gained from eating, lost from exercise/processes




Nutrition Labels

Nutrition Facts	
Serving size: 1 potato (149g/5.2oz)	
Amount per serving	
Calories	110
% Daily Value*	
Total Fat 0g	0%
Saturated Fat 0g	0%
Trans Fat 0g	0%
Cholesterol 0mg	0%
Sodium 0mg	0%
Total Carbohydrate 26g	9%
Dietary Fiber 2g	3%
Total Sugars 1g	0%
Includes 0g Added Sugars	0%
Protein 4g	8%
Vitamins	
Vitamin D 0mg	0%
Calcium 20mg	2%
Iron 1mg	4%
Phosphorus 60mg	1%
Vitamin C 27mg	30%
Vitamin B ₆ 0.2mg	10%

Carbohydrates

2-6 grams per pound BW


60% of calories



Protein


½-1 gram per kilogram BW

15% of calories



Fats

20-30% of total calories




Micronutrients

18 mg iron

1,000 mg calcium ~ 4 8oz glasses

1,340 mg vitamin D



Hydration

Performance compromised in deficits of 2% of BW

BW/2 → oz per pound



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Figure A2: Qualitative Presentation

Female Athlete Nutrition Course

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Qualitative Education

Home vs. Restaurant

Home Cooking > Eating Out

(Tiwari et al, 2017)




Whole vs. Processed

Minimally processed

Processed


Highly processed



Carbohydrates

Starchy vegetables, fruits, whole grains, beans, and dairy


Most important



Protein

Meat, fish and seafood, eggs, dairy, grains, beans, nuts, and seeds


Baked, grilled, or broiled



Fats

Fatty fish, nuts and seeds, avocados, olives, and vegetable oils

Plant-based & Omega-3 fatty acids



Micronutrients

Dark meats, leafy veggies & oysters for iron

Dairy products & leafy veggies for calcium

Sun exposure for vitamin D



Hydration

Performance compromised in deficits of 2% of BW

BW/2 → oz per pound



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