

2014

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Maria Castelan

Cristal Choara

Nayeli Guerrero

Jaimie Orozco

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Recommended Citation

Castelan, Maria; Choara, Cristal; Guerrero, Nayeli; and Orozco, Jaimie (2014) "Relationship between Lipid Ingestion and Blood Glucose Metabolism," *OSR Journal of Student Research*: Vol. 2 , Article 10.

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Relationship between Lipid Ingestion and Blood Glucose Metabolism

Maria Castelan, Cristal Choara, Nayeli Guerrero and Jaimie Orozco

Abstract

Background: It has been shown that the consumption of carbohydrates increases the glycemic response. The objective of our study was to demonstrate the effects of the glycemic index when carbohydrates were independently consumed and when carbohydrates and lipids were consumed jointly. Our findings indicate that the glycemic index was not significantly affected by the consumption of carbohydrates and lipids.

Methods: Fifty-nine subjects were screened for a glucose tolerance test where the participants fasted overnight, 10-12 hours. Subjects obtained a fasting glucose level test in order to obtain their blood glucose baseline. The glucometer, ReliOn Ultima, model No. 66004-0122-05, was used to conduct the study. Once the baseline was obtained subjects were then given a bagel that contained 50 grams of carbohydrates. Participants obtained a blood glucose level every 30 minutes after the consumption of the bagel and were allowed to drink 8 oz. of water. In order to demonstrate the effects of lipid consumption in relation to the glycemic index response, subjects were given a tablespoon of cream cheese. The results were compared to fasting serum blood glucose.

Results: Participants blood glucose level increased slower when given a tablespoon of

Keywords: *Glycemic index, glycemic response, lipids, carbohydrate intake, blood glucose baseline*

cream cheese in conjunction with the 50 grams of carbohydrates.

Conclusion: Our study concluded that the consumption of carbohydrates with lipids delayed the glycemic response. However, it does not significantly delay the response. A limiting factor in our study that may have contributed to our results was our experiments population size.

Author Interview for Maria

Which professors (if any) have helped you in your research or creative activity?

Dr. Chen has helped me in my research.

What are your research or creative interests?

I would like to research and expand my knowledge in the field of nutritional psychology. I am very interested to explore how our thoughts and emotions affect our eating behavior.

What are your plans after earning your degree? What is your ultimate career goal?

After completing my B.S. in Nutrition and Food Science, I plan to complete a dietetic internship, sit for and pass my state exam in order to become a Registered Dietitian. My ultimate career goals included pursuing a career in Community Nutrition and obtaining a graduate degree in Nutritional Psychology. I hope to become a licensed Nutritional counselor.

Introduction

People have become more aware of the regulation of blood glucose levels since there has been an increase in diseases that are linked to high blood glucose levels. Diets high in carbohydrates raise blood glucose levels, insulin and lipids (1). The glycemic index (GI) is an aid that helps regulate blood glucose by measuring the amount of carbohydrates a food has. The glycemic index can be defined as a numerical guide that measures the amount of glucose in the blood regarding the amount of sugar and carbohydrate-rich foods consumed. Health professionals, especially those treating diabetes, know what an important tool the glycemic index is for regulating blood glucose levels and aim to inform the public about keeping balanced blood glucose levels to prevent ailments. Studies have shown that diets high in carbohydrate consumption raise plasma glucose thus causing insulin resistance. This can be seen in individuals who do not exercise and have a diet high in carbohydrates. On the other hand, low GI foods have been shown to reduce insulin sensitivity especially for individuals with glucose impairments. Gender and age are factors that may or may not contribute to the value of one's glycemic index as well. The glycemic index is also affected by the foods we consume. Lipids and carbohydrates consumed jointly will affect the glycemic response by causing it to rise less than when carbohydrates are consumed independently. The relevance of lipid consumption and its effect on glycemic response are very relevant in today's increasing population that presents chronic conditions associated with low glycemic response. For this purpose, this should be considered when working with patients who suffer from diabetes and health conditions associated with decreased glycemic response.

Methods

A total of 59 subjects were screened for a glucose tolerance test. The test was performed using the finger stick capillary method. The participants were asked to fast for a period of 10-12 hours, and abstain from having any beverages aside from water. As a reference number, participants were administered a fasting glucose level test in order to access baseline glucose

levels. All fasting tests were done at 8 am.

To test for glucose we used the ReliOn Ultima, model No. 66004-0122-05. The method used was the finger capillary method. This method requires participants to puncture the lateral side of any given finger using a 2.5 mm lancet. In order to prepare the finger before each punctures the participants were instructed to use rubbing alcohol to properly clean their finger. In order to better ensure the results of the GTT, the participants were asked to wipe off the first drop of blood. The reason behind this rational is that the first drop might contain a mixture of alcohol and this would affect test results. The second drop of blood was then placed next to the reagent strip.

For the purpose of this test the participants were asked to take their baseline blood glucose levels after an overnight fast. Although the actual fasting time for this study was of 10-12 hours the values we used to set the range for baseline blood glucose levels was that of 3-4 hours. According to the 1999 WHO Diabetes Criteria interpretation of OGTT, normal range for fasting glucose is <110mg/dL (2). All baseline levels for each participant were considered normal and fell between the ranges of 63-105 mg/dL. After baseline data was collected participants had 15 minutes to eat a 50 grams carbohydrate Thomas bagel. The only fluid that the participants were allowed to consume was 8 ounces of water. The participants were instructed to perform a GTT every 30 minutes after the consumption of the carbohydrate (bagel). In order to take an accurate measure of time and process, participants were also asked to write down the time in which they had to take their GTT and the time they finished administering the GTT.

In order to access the effects of lipid consumption in relation to glycemic index response, participants were given one serving of cream cheese (1 tablespoon) on a Thomas bagel. According to the Philadelphia Cream Cheese nutrition panel, 1 tablespoon of regular cream cheese has 4.5 grams of total fat. The results of GTT were compared to baseline glucose levels. The data of the two tests (50 grams of carbohydrate and 50 grams of carbohydrate with 4.5 grams of fat) were compared against each other to note how glycemic index responds to each.

Statistical Methods

The participants for this study were between the ages 20 and 40 years of age. The study included 51 females and 8 males. There were no specific criteria for the choosing of the participants, thus making our study randomized. The study included participants from different backgrounds, socioeconomic status and ethnicity.

Results

Participants in this study consisted of a group of 51 females and 8 males, ages ranging from 20- 40 years. Other factors such as physical characteristics: BMI, weight, and height were not accounted for in this study. Consideration should be given to the size of the population used in our study as our P-test statistical results showed our probability value was greater than .30. To account for the chance of slowed blood glucose metabolism after the consumption of fat, our population size must be greater in amount of subjects. This level should be less than .05; therefore, our experiment is not fully significant in this population size and further testing is needed (Table 5).

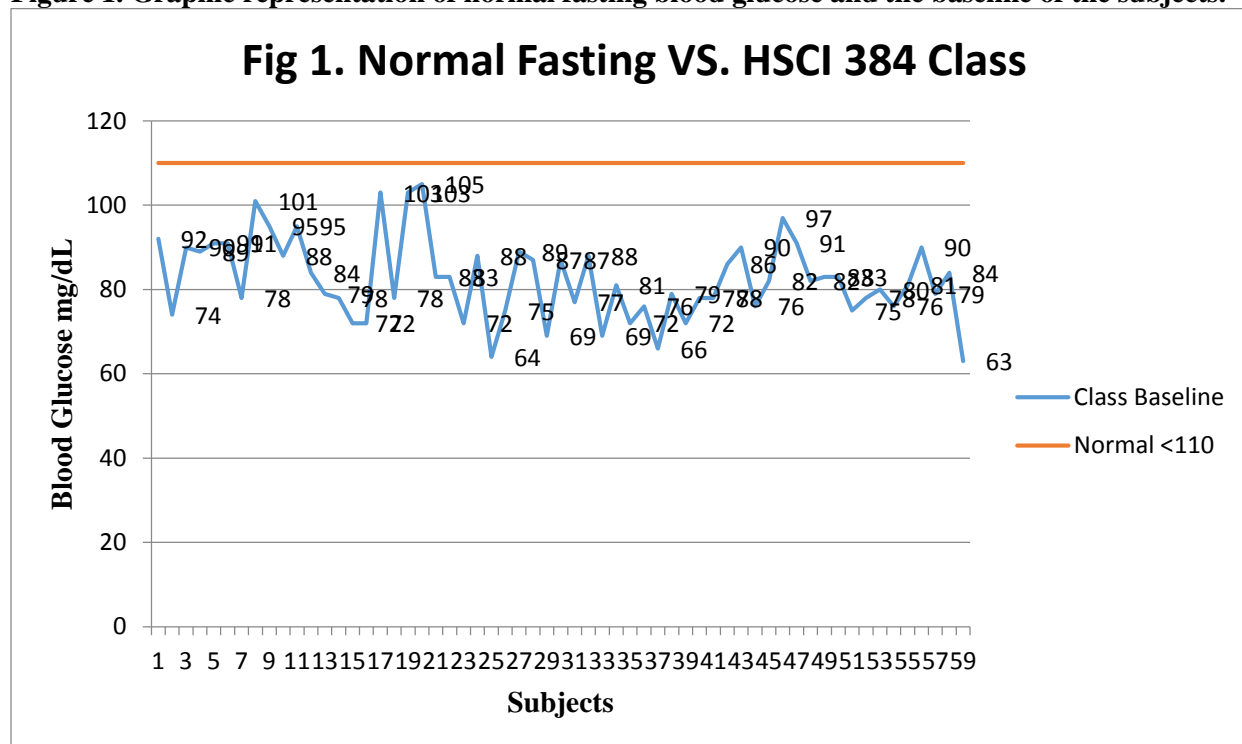
T-Test: Two-Sample Assuming Unequal Variances

	Bagel	Bagel w/CC
	Variable 1	Variable 2
Mean	109.1818182	105.6307692
Variance	255.3636364	285.2082744
Observations	11	13
Hypothesized Mean Difference	0	
df	22	
t Stat	0.528455801	
P(T<=t) one-tail	0.301236952	
t Critical one-tail	1.717144374	
P(T<=t) two-tail	0.602473904	
t Critical two-tail	2.073873068	

Table 5. T-Test for bagel and bagel with cream cheese. $P(T \leq t)$ one tail = 0.301

The variables of interest in this study were the glycemic response in this population of individuals after consumption of 50 grams of carbohydrate with and without lipid ingestion in the form of a bagel with one tablespoon of cream cheese. The 50 grams of carbohydrate were obtained from the consumption of one Thomas bagel per participant. Certain participants were given one tablespoon of Philadelphia cream cheese. Each tablespoon of cream cheese contained 4.5 grams of fat. The cream cheese was our representation of fat intake.

Prior to the consumption of the bagel and cream cheese, participants measured and recorded their fasting blood glucose levels. From the information obtained, all of the participants in the study recorded serum blood glucose levels within 63-105 mg/dl. This means that all of the participants had a blood glucose reading that was less than 110 mg/dl and their fasting blood glucose was within the range considered to be "normal." The "Normal Fasting vs. HSCI 384 Class" Fig. 1 shows that all of the participant's serum blood glucose remained within the normal range when their fasting blood glucose levels were measured after the required three hour fasting period.

Figure 1. Graphic representation of normal fasting blood glucose and the baseline of the subjects.

“Fasting Serum Blood Glucose vs. Intake of Carbohydrate” Fig. 2 showed the association between our second variable of interest which was the activity of blood glucose response to 50 grams of carbohydrate. The relationships between the values obtained from the population were as follows: the average blood glucose levels of the participants decreased compared to the levels of fasting blood glucose; serum blood

glucose levels showed a slow decline while average blood glucose levels showed a steady and quicker decline that reached baseline blood glucose levels much faster than serum blood glucose levels. Figure 2 shows this progression as blood glucose levels were monitored and recorded after 30 minute intervals within a 195 minute period.

Figure 2. Graphic representation of normal serum blood glucose and average blood glucose intake of a 50 g bagel.

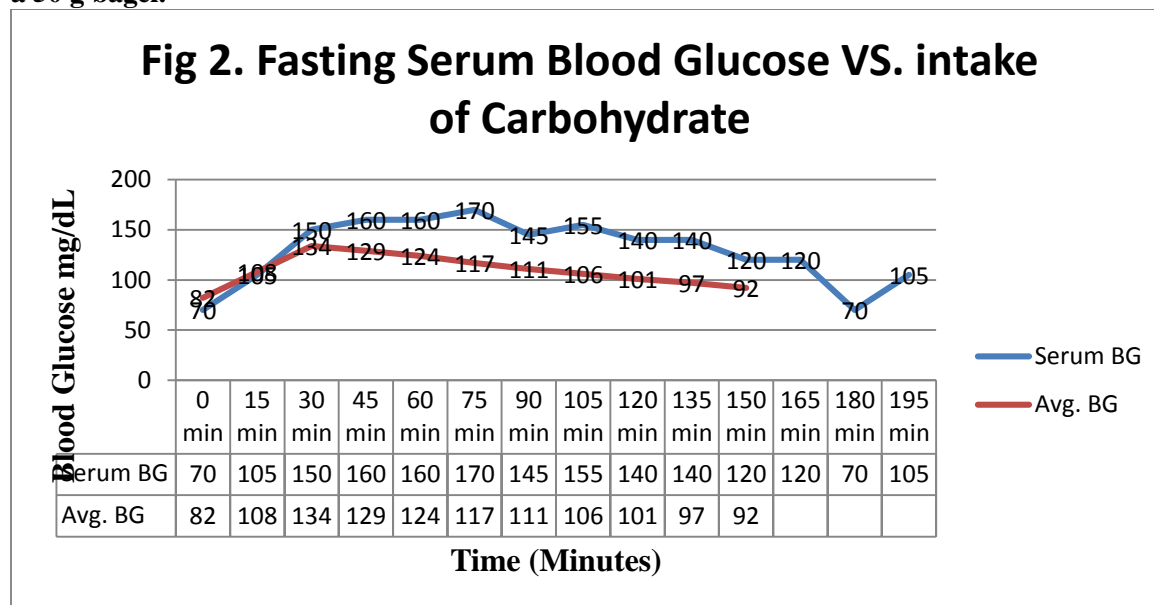


Figure 3. Graphic representation of average blood glucose with bagel and 1 Tbsps. cream cheese v. fasting serum BG.

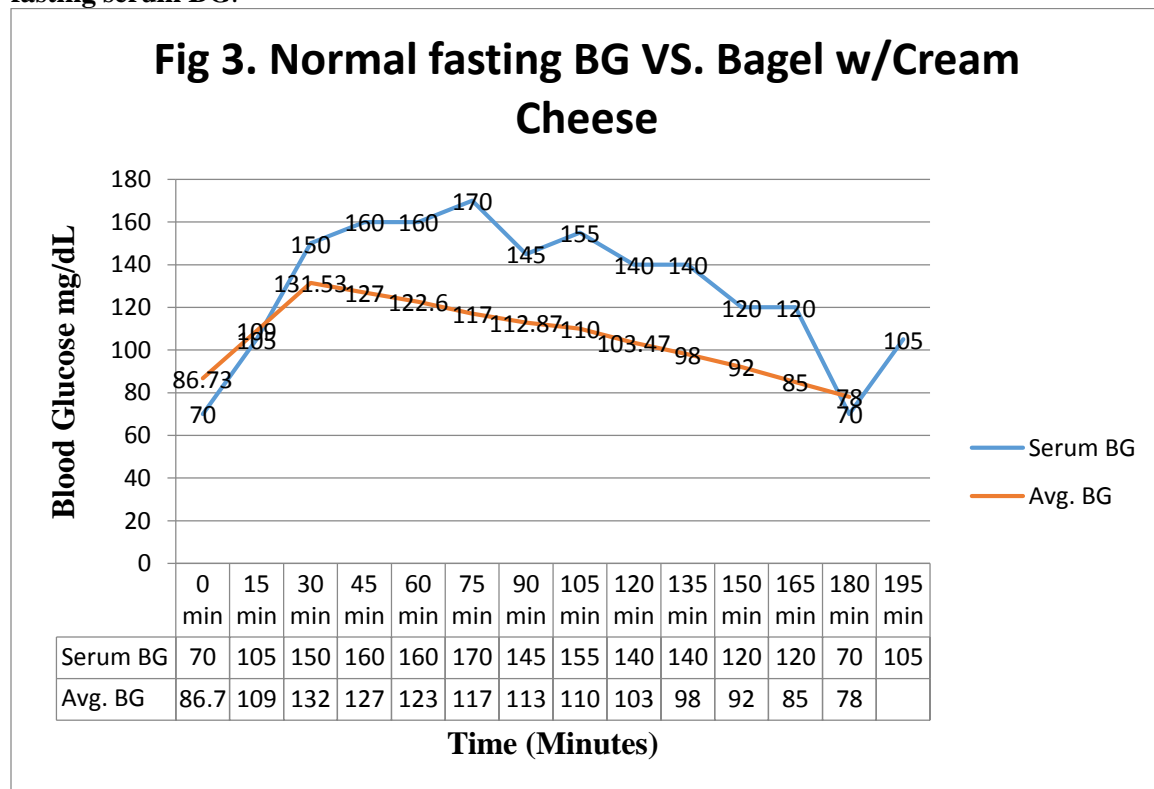
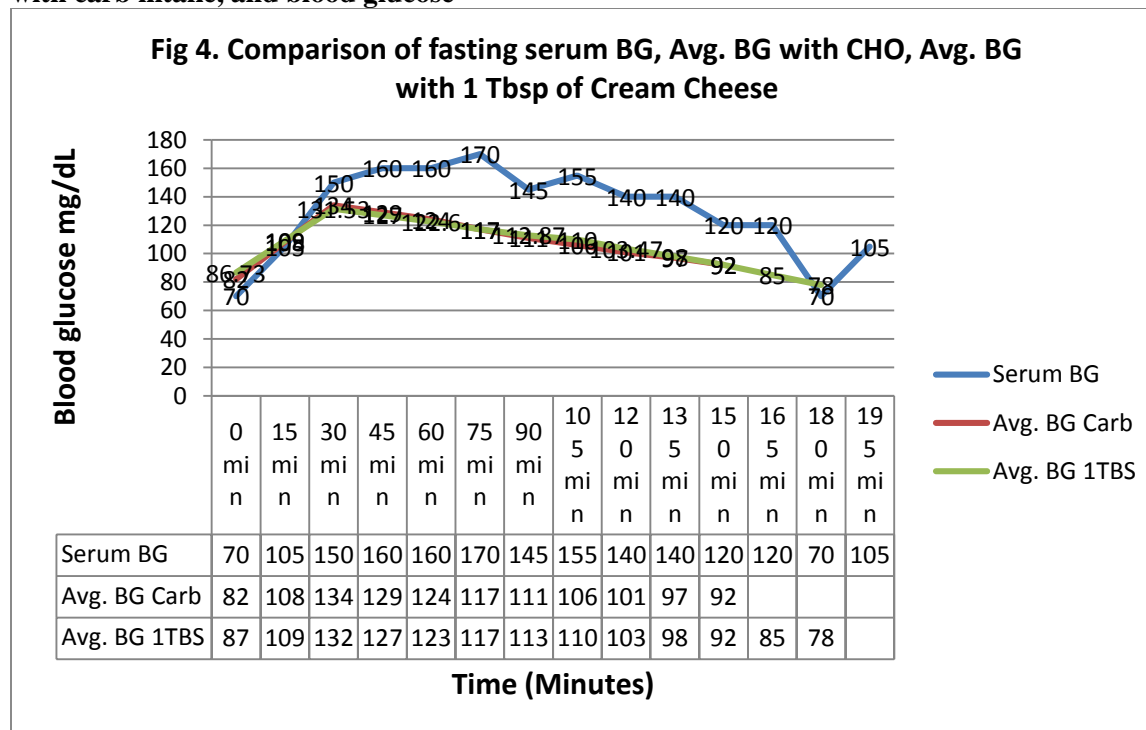


Figure 3, “Normal Fasting Blood Glucose vs. Bagel with Cream Cheese” reflects information acquired from our section of the study that focused on finding how the fat intake would affect fasting blood glucose levels. One tablespoon of cream cheese contained 4.5 grams of fat. After consuming one tablespoon of cream cheese, serum blood glucose levels were also recorded after thirty minute intervals for a total of 195 minutes.

Figure 4, “Serum Blood Glucose vs. Average Blood Glucose with Carbohydrate vs. Average Blood Glucose with Carbohydrate and

1Tbsp of Cream Cheese” depicts our two variables of interest in relationship to each other and fasting serum blood glucose levels. Figure 4 shows fasting serum blood glucose levels remained elevated than levels recorded after the consumption of carbohydrate and carbohydrate with fat. Our data supports that cream cheese slightly decreased glycemic response when compared to only the consumption of 50 grams carbohydrate. Therefore, the overall effect of lipid consumption on glycemic response was only slightly slower from only the consumption of carbohydrate intake.

Figure 4. Graphic representation of the comparison of fasting serum blood glucose, blood glucose with carb intake, and blood glucose



From the data we obtained in this study, we found that average blood glucose levels were slightly influenced after the consumption of carbohydrates and carbohydrates with lipids. According to a study conducted by Sans et al (1981) rats that were fed fat had significantly less glucose transported across the plasma membrane and less glucose was used in the cells. This observation can be associated with a decrease in basal and insulin stimulated metabolism (3). Data

recorded from the consumption of 50 grams of carbohydrate after the consumption of a bagel per participant supported that there is an increase in glycemic response and glucose tolerance because there was a slowed blood glucose response after the consumption of carbohydrate with and without fat. As noted in Sans et al, the consumption of bagel with cream cheese appeared to further decrease the sensitivity of blood glucose (3). Similarly, the intake of lipids

with carbohydrate appeared to have a similar effect on glycemic response. The data we acquired from this study supports our hypothesis that lipid consumption does affect overall glycemic response as it showed to increase the tolerance of glucose in the blood after one tablespoon of cream cheese with 50 grams of carbohydrate of the bagel were consumed. This may be associated to the increase in insulin secretion by the body to metabolize blood glucose and the decrease in the body's cells to use this glucose (4). As a result, more blood glucose was present in the blood for a longer time as presented by our data in Fig. 4.

Discussion

Results from this study support our hypothesis of interest; lipid ingestion decreases the glycemic response of food. Our study was focused on two variables: blood glucose affects after the consumption of 50 grams of carbohydrate with and without fat. Our findings on the glycemic response to 50 grams of only carbohydrate intake after fasting for three hours suggest that 50 grams of carbohydrate will cause an increase in glycemic response within normal serum blood glucose levels during 30-minute intervals. The information from our study reinforces our hypothesis based on our findings that lipid consumption also decreased glycemic response after the consumption of 50 grams of carbohydrate with one tablespoon of cream cheese. Although one tablespoon of cream cheese contained only 4.5 grams of fat, it influenced the glycemic response of our participants enough to slightly decrease glucose response levels throughout a 195 minute period. Blood glucose levels recorded from the consumption of fat showed a slight decline in glycemic response. This suggested that lipid intake does decrease the ability of the body to metabolize carbohydrate once fat is consumed. However, the glycemic response was only slightly decreased when compared to the intake of only carbohydrate. This information shows a close response as reported by Lichtenstein & Schwab (2000) found that fat consumption will increase insulin resistance. Increase in insulin resistance was found to be associated to increased production of C-peptide levels by pancreatic beta cells responsible for

insulin production; this increase in C-peptide levels leads to increased insulin production (4). As a result, this supports our findings by proposing that the decline in the body's ability to metabolize carbohydrate after lipid consumption may be attributed to influences in the body's cells by lipid ingestion.

Future studies focused on finding the influence of lipid intake on glycemic response should incorporate a higher content of fat into future studies. Our findings support that there is a decrease in glycemic response; however, the decrease is only slightly lower than that of the consumption of carbohydrate without lipid. As a result, a larger portion of fat, or cream cheese with a higher fat content could be used to determine if a greater increase in fat content consumption will further decrease glycemic response in fasting blood glucose levels. Other studies have also suggested that fat intake declines glycemic response. Nevertheless, studies should be conducted which not only increase the amount of fat content but also experiment with various types of fat consumed.

In addition, future studies should incorporate a larger population size to eliminate areas of error in their results; studies should also account for participant's BMI to determine if BMI has significance in individual ability to regulate glycemic response. One of the weaknesses found in our study was related to our P-test statistical level. Our P-test statistical level was too high for a population of our size limiting our ability to give a conclusion free of error. Our recommendation of a larger population size may help minimize the significance of statistical error in the results which may lead to a more accurate and definite conclusion about the impact of lipid ingestion on blood glucose metabolism. Equally important, the integration of the effect of lipid on blood glucose regulation in regards to BMI may help attain more accurate results related to participants' body composition. BMI was not a factor accounted for in our study and we believe integrating it as a factor of focus in future studies may also assist in formulating more specific conclusions about glycemic response specifically related to a measure of body mass index. Due to the fact that BMI is related body mass index, the findings obtained from future studies may be correlated to this factor as BMI has been used for

assessing physical health status in regards to potential health risks associated with BMI.

The most significant strength of our study was our ability to consistently monitor and record blood glucose levels at specified thirty-minute intervals. The capacity to monitor and record blood glucose levels at specified intervals minimized our chance of inconsistent data entries. In addition, only participants who did not suffer from known diabetes were included in our study as a way to obtain reliable results pertaining to blood glucose activity resulting from our variables of interest. Another of our weaknesses may have been our lack of ability to regulate the time at which participants recorded their blood glucose readings after measuring their blood glucose levels with the instruments provided. Due to the fact that participants started recording their blood glucose levels at different times, some of the participants started to record their data a few minutes before others. This may also be a key factor in our study which could be changed by future studies by better regulating the times at which individuals will draw and measure blood glucose levels.

The relevance of lipid consumption and its effect on glycemic response are very relevant in today's increasing population that presents chronic conditions associated with low glycemic response. Educating the public about developing healthy balanced meals may help reduce the risk of developing chronic disease. In addition, choosing to eat a balanced meal will help our body regulate the amount of glucose that enters our system. This is especially true when it comes

to regulating the different metabolic pathways. As supported by our findings, fat ingestion results in a decreased glycemic response. For this purpose, this should be considered when working with patients who suffer from diabetes and health conditions associated with decreased glycemic response.

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