Exploring Optimal Macronutrient Composition in Nutrition Therapy for Type 2 Diabetes

Introduction

Diabetes is increasingly becoming a greater threat to the overall health of the United States' population. According to the National Diabetes Statistics Report (2017) published by the CDC (Centers for Disease Control), it was estimated that 30.3 million people (9.4% of the total American population) have diabetes.[1] In addition, an increase in the prevalence of diabetes is expected in the forthcoming years. Type 1 diabetes accounts for approximately 5% of all cases of diabetes reported, while Type 2 diabetes accounts for 90 – 95% of all cases reported.[1] For this reason, diet intervention in Type 2 diabetes will be the focus of this research paper. The goal is to see if specific macronutrients in the diet are superior in Type 2 diabetes nutrition therapy by exploring and analyzing reviewed research regarding different macronutrient compositions in Type 2 diabetes diet interventions. The conclusion will give an answer to the following question: "Is there an optimal macronutrient composition for diet intervention in patients with Type 2 diabetes?"

What Is Covered

Among research articles related to Type 2 diabetes diet intervention and macronutrient composition, the glycemic response has been found to be a prevalent parameter that is measured and analyzed frequently. In simple terms, the glycemic response is the effect food has on blood glucose and is induced by carbohydrate intake.[2] Those with Type 2 diabetes have a hindered ability to regulate blood glucose adequately; therefore, overall glycemic control is significant in studies relating to Type 2 diabetic nutrition therapy. Because of the emphasis placed on glycemic control, an abundance of research involving Type 2 diabetes nutrition therapy and macronutrient composition targets the comparison between carbohydrate focused diets versus

protein or fat focused diets. Therefore, the following paragraphs will review research articles that investigated the effects different macronutrient composed diets have on individuals with Type 2 diabetes in relation to carbohydrate emphasized diets versus fat or protein emphasized diets.

Higher Protein versus Higher Carbohydrate Diets: Sargrad Study

The first area of focus in relation to different macronutrient composed diets is a higher protein versus a higher carbohydrate diet. The reviewed research focused on the comparison of these two diets in order to analyze key differences that may indicate whether one diet is superior. Sargrad and colleagues utilized a stratified randomization procedure to find participants for a study that focused on the effects of a high-protein diet (40% carbohydrate, 30% protein, 30% fat) versus a high-carbohydrate diet (55% carbohydrate, 15% protein, 30% fat) in 12 obese participants with Type 2 diabetes. The aim was to determine if there was any superiority between the two diets, as well as simplifying the study criteria from a previous study in hopes of improving test compliance. Compliance in Type 2 diabetes nutrition therapy is relatively low, with greater degrees of poorness seen with extremes in carbohydrate/protein content and as study duration increases.[3] Over the course of two months (eight weeks), six participants (five women, one man) consumed the high-carbohydrate diet while the other six participants (four women, two men) consumed the high-protein diet. The following parameters were measured and tracked throughout the eight-week study: body weight, body composition, insulin sensitivity, glycemic control, blood pressure, and plasma lipid levels.

The results revealed that both groups lost weight (-2.2+/-0.9 kg, -2.5+/-1.6 kg) with no significant differences between the two. However, the high-carbohydrate group experienced a decrease in HbA1c (8.2% to 6.9%) and a decrease in fasting plasma glucose (8.8 to 7.2 mmol/L).

The high-carbohydrate group also experienced a significant increase in insulin sensitivity (12.8 to 17.2 micromol/kg/min), which suggests that there was improvement in glycemic control. Interestingly, the high-protein group experienced no significant changes in the parameters analyzed. However, the high-protein group saw a significant decrease in blood pressure (diastolic: −18±9.0 mmHg, systolic: −10.5±2.3 mmHg) while the high-carbohydrate group saw no significant change. Therefore, the results derived from the Sargrad study suggested that either a high-protein or high-carbohydrate diet were superior in Type 2 diabetes diet intervention.[3]

Larsen Study

Larsen and colleagues also focused on utilizing high-protein versus high-carbohydrate macronutrient composed diets for Type 2 diabetes nutrition therapy. The second study was a 12-month randomized controlled trial in which researchers compared the effects of a high-protein, low-fat diet (30% protein, 40% carbohydrates, 30% fat) with a high-carbohydrate, low-fat diet (15% protein, 55% carbohydrates, 30% fat) on glycemic control in individuals with Type 2 diabetes.[4] The purpose of the study was to see if either diet was superior in Type 2 diabetes nutrition therapy. The participants in the study were classified as either overweight or obese, with a BMI ranging from 27 – 40 (kg/m^2). A total of 99 individuals, from 30 to 75-years-old, were placed in two groups. Fifty-three individuals were placed in the high protein group while 46 individuals were placed in the high carbohydrate group. The following anthropometric and metabolic parameters were analyzed: HbA1c, weight, and glycemic control. Parameters were measured at baseline and re-measured in three-month increments from the beginning of the study to the end point of the 12-month duration.[4]

Overall, the results revealed there were no significant differences in either of the two test groups with both seeing equal improvements. Both groups saw changes in HbA1c (high-protein

group: -0.52% after 3 months, -0.23% after 12 months; high-carbohydrate group: -0.49% after 3 months, -0.28% after 12 months). The changes were non-significant. Changes in weight occurred in both groups (high-protein group: -2.79 kg after 3 months, -2.23kg after 12 months; high-carbohydrate group: -3.08 kg after 3 months, -2.17kg after 12 months). Despite the lack of differences observed in both diet test groups, glycemic control improved throughout the duration of the study. The results derived from the Larsen study suggested that a higher protein, low-fat diet is not superior to a higher carbohydrate, low-fat diet in Type 2 diabetes diet intervention.[4]

Pedersen Study

A 12-month, parallel, randomized study conducted by Pedersen and colleagues, consisted of a comparison between a higher protein, lower carbohydrate diet (30% protein, 30% fat, 40% carbohydrate) and a standard protein, higher carbohydrate diet (20% protein, 30% fat, 50% carbohydrate). This study was conducted with 45 participants (35 men, 10 women) with Type 2 diabetes in order to see if either of the two diets were superior in Type 2 diabetes nutrition therapy. Twenty-one participants were placed in the standard protein group and 24 participants were placed in the high-protein group. Measurements were taken at baseline, four months, eight months and 12 months. The following parameters were analyzed: fasting blood glucose, HbA1c, and blood pressure.[5]

The results revealed that fasting blood glucose decreased significantly at 12 months (high-protein diet group: −1.0 ± 0.3, standard protein diet group: −1.5 ± 0.5 mmol/L) with little differences seen between the two groups. Overall, HbA1c decreased significantly in both groups overtime. However, there was a significant difference found between the two groups at 6 months (higher protein diet group −0.9%, standard protein diet group −0.3%), but this difference was less pronounced at 12 months (higher protein diet group −0.4%, standard protein diet group

−0.3%). Blood pressure, a risk factor closely associated with the development of Type 2 diabetes,[6] was measured at baseline (higher protein diet group averaged 127/75 mmHg, standard protein diet group averaged 128/72 mmHg). Blood pressure decreased slightly in the high-protein diet group while the standard protein diet group saw no significant change (high-protein diet group averaged 123/72 mmHg, standard protein diet group averaged 127/75 mmHg). The results derived from the Pedersen study indicated that although improvements in blood pressure measures were seen in both higher protein and standard protein diet groups, the higher protein group experienced greater improvements. Collectively, both diet groups experienced similar improvements in anthropometric and metabolic parameters.[5]

Limitations in Comparison of Sargrad, Larsen, and Pedersen Studies

Limitations were encountered during the higher protein and higher carbohydrate diet comparison. Each study focused on different parameters. However, the parameters covered in the analysis in this paper appeared to be consistent with the parameters emphasized in the three studies. Compliance among the test participants appeared to be difficult to achieve. The three studies each tested different numbers of test populations, leading to an inconsistency in number of participants in the three studies. Lastly, there were different test durations among the three studies, which may have contributed to compromised validity in the comparison between the Sargrad, Larsen, and Pedersen studies.[3-5]

Higher Protein versus Higher Carbohydrate Diets: Conclusion

The indications from Sargrad, Larsen, and Pedersen studies could not collectively pinpoint conclusion that there was any superiority in a higher protein diet versus a higher carbohydrate diet. The final results derived from each study did not adequately concur. Due to the variations of findings, there are indications of a gap in research relating to the effect

differences in macronutrient composition in Type 2 diabetes nutrition therapy. However, a collective conclusion can be made by all three of the studies; all indicated that no matter the macronutrient composition in relation to a higher protein or a higher carbohydrate diet, improvements were made in the health of the Type 2 diabetes patients involved in the diet intervention tests. This collective conclusion may indicate that there is no superiority in either a higher protein or higher carbohydrate diets in relation to Type 2 diabetes nutrition therapy; rather it is the quality of the nutrition in the diets themselves that contributes to the overall health improvement in nutritional treatment.[3-5]

Higher Fat versus Higher Carbohydrate Diets: Brehm Study

The second area of focus related to different macronutrient composed diets is a higher fat versus a higher carbohydrate diet comparison. The reviewed research focused on the comparison of these two diets in order to analyze key differences that may indicate whether one diet is superior. The purpose of the study conducted by Brehm and colleagues was to compare the effects of a high-carbohydrate (CHO) diet to the effects of high-monounsaturated fatty acid (MUFA) diet in individuals with Type 2 diabetes in order to determine if one diet was superior. The following criteria displays both of the diets' macronutrient compositions: high-CHO (60% carbohydrate, 15% protein, 25% fat) and high-MUFA (45% carbohydrate, 15% protein, and 40% fat) with half of the fat being MUFA. A total of 124 overweight/obese individuals (46 men, 78 women) with Type 2 diabetes were enrolled in the study. The participants were either in the high-CHO group or the high-MUFA group. The overall retention rate for the 1-year study was 77% (69% for the high-MUFA group, 84% for the high-CHO group). Anthropometric and metabolic parameters were measured at baseline and after four, eight, and 12 months of dieting.

The parameters measured and analyzed included weight, total cholesterol, HDL-cholesterol, blood pressure, A1C (%), fasting glucose, and insulin.[7]

Results from the Brehm study revealed notable changes in anthropometric and metabolic parameters. Weight loss was similar in both groups over the 1-year study (high-CHO: −4.0 ± 0.8, high-MUFA: −3.8 ± 0.6 kg). A similar increase in HDL-cholesterol (mg/dL) was observed in both groups (high-CHO: 43 ± 1.4 at baseline, 48 ± 1.4 at 12 months; high-MUFA: 42 ± 1.2 at baseline, 47 ± 1.3 at 12 months). A1C (%) increased in both groups at four months (high-CHO: 7.2 ± 0.1 at baseline, 6.8 ± 0.1 at 4 months; high-MUFA: 7.4 ± 0.1 at baseline, 6.8 ± 0.2 at 4 months). Interestingly, both groups increased back to nearly baseline at 12 months (high-CHO: 6.8 ± 0.2 at 4 months, 7.2 ± 0.1 at 12 months; high-MUFA: 6.8 ± 0.2 at 4 months, 7.5 ± 0.3 at 12 months). Fasting glucose was taken after 10 hours of the participants' last meal. Similar improvements in fasting glucose were seen in both groups (high-CHO: 135 ± 4.7 at baseline, 127 ± 5.5 – 12 months; high-MUFA: 150 ± 7.0 at baseline, 142 ± 8.1 at 12 months). Insulin (pmol/L) was improved in both groups. However, greater improvements were observed in the high-MUFA group compared to the high-CHO group (high-CHO: 314 ± 37.1 at baseline, 287 ± 26.7 at 12 months; high-MUFA 309 ± 25.4 at baseline, 251 ± 23.6 at 12 months). At 18 months, researchers reviewed the parameters again. The gathered results indicated similar improvements in all parameters, which indicates that either of the two diets are not superior.[7]

Gaesser Study

Gaesser and colleagues conducted a randomized crossover study that compared the effects of a low-fat, high-fiber diet to and a high-fat, low-carbohydrate diet with patients with metabolic syndrome (factors that increase risk of heart disease, stroke, and diabetes). Although this study focused on nutrition therapy for metabolic syndrome and not Type 2 diabetes,

metabolic syndrome is measured with similar parameters that are closely associated with Type 2 diabetes, which makes the Gaesser study valid for the topic of this paper.[8]

The goal of the study was to specifically examine changes in insulin sensitivity and vascular endothelial function. The two diets used in the study were non-calorically restricted and the duration of the study was four weeks. The test population consisted of 23 women and men, ages 32 to 62-years-old. All of the participants in the study were diagnosed with metabolic syndrome. The Gaesser study included insulin, insulin sensitivity, and blood glucose as anthropometric and metabolic parameters that were measured and analyzed for four weeks. All meals included consisted of the following criteria: low-fat, high-fiber (55-60% carbohydrate, 20-25% fat, 15-20% protein, 38-48g fiber/day) and higher fat, low-carbohydrate (15-20% carbohydrate, 55-60% fat, 25-30% protein, 9-11g fiber/day).[8]

Results revealed similar decreases in insulin [mean (SEM), uU/ml] (low-fat, high-fiber diet group: 12.6 ± 1.6 at baseline, 9.9 ± 1.2 at 4 weeks; higher fat, low-carbohydrate: 11.8 ± 1.2 at baseline, 9.8 ± 1.0 at 4 weeks). Insulin sensitivity (QUICKI) was improved almost identically in both groups (low-fat, high-fiber diet group: 0.315 ± 0.006 at baseline, 0.326 ± 0.006 at 4 weeks; higher fat, low-carbohydrate diet group: 0.315 ± 0.006 at baseline, 0.326 ± 0.007 at 4 weeks). Blood glucose levels (mg/dL) were reduced in the low-fat, high-fiber diet group (100.1 ± 2.4 at baseline, 96.9 ± 2.2 at 4 weeks), but no significant changes in blood glucose were seen in the higher fat, low-carbohydrate diet group. In addition to the lack of significant change in blood glucose, the higher fat, low-carbohydrate group also experienced impaired vascular endothelial function compared to the low-fat, high-fiber group, which experienced no significant change. Therefore, the results from the Gaesser study indicated that a low-fat, high-fiber diet was

superior compared to a higher fat, low-carbohydrate diet for metabolic syndrome nutrition therapy.[8]

Davis Study

Davis and colleagues conducted a 1-year, randomized clinical trial with the purpose of comparing the effects of a low-carbohydrate and a low-fat diet on weight loss and glycemic control in patients with Type 2 diabetes. A total of 105 participants with Type 2 diabetes were enrolled in the study. Fifty-five participants were placed in the low-carbohydrate group and 50 were placed in the low-fat group. The participants consumed either of the two diets for a duration of one year. Quantitative measurements were taken at baseline, and then re-measured at three, six, and 12 months. Parameters analyzed in the Davis study include weight, A1C (%), HDL-cholesterol, and blood pressure.[9]

The results revealed that weight loss occurred in both diet groups, with a greater loss seen in the low-carbohydrate group compared to the low-fat group (low-carbohydrate group: -13.1kg ± 3.7 at 12 months, low-fat group: -6.5kg ± 4.9 at 12 months). A1C (%) also decreased in both diet groups (low-carbohydrate group: -0.95% ± 3.2 at 12 months, low-fat group: -0.17% ± 1.2 at 12 months). However, the changes in A1C (%) were not significant. HDL-cholesterol (mmol/L) increased significantly in both diet groups (low-carbohydrate group: 0.32 ± 0.27 at 12 months, low-fat group: 0.05 ± 0.21 at 12 months). Blood pressure (mm/Hg) decreased slightly in both groups (low-carbohydrate group: -4.58 ± 17.5 systolic, -6.03 ± 11.4 diastolic; low-fat group: -6.48 ± 21.1 systolic, -1.65 ± 11.3 diastolic). The decreases in blood pressure were not significant. The potential of skewed results could be attributed to the decrease in adherence, indicated by increases in caloric intake in both groups. This was noted by Davis and colleagues, “at 6 and 12 months, there was an increase in calories and macronutrients in both groups,

suggesting decreased adherence."[9] Collectively, the results derived from the Davis study indicated that either of the two diets were not superior.[9]

Limitations in Comparison of Brehm, Gaesser, and Davis Studies

Limitations were encountered in comparing the higher fat and higher carbohydrate diets. The limitations seen in the Brehm, Gaesser, and Davis studies were similar to those noted in the Sargrad, Larsen, and Pedersen studies.[3-5,7-9] There were variations of parameters analyzed in each of the Brehm, Gaesser, and Davis studies. Compliance among the test participants was a limitation, as well as test adherence. Adherence was a problem in the Davis and Brehm studies, which lasted longer (1-year studies) than the Gaesser study (4-week study).[9] Therefore, a variation in test duration was seen.[7-9]

Higher Fat versus Higher Carbohydrate Diets: Conclusion

The indications from the Brehm, Gaesser, and Davis studies could not collectively come to conclusion that either a higher fat or a higher carbohydrate diet was superior in Type 2 diabetes nutrition therapy. The final results derived from each study did not adequately concur. Due to this inconsistency, there are indications of a gap in research relating to the effect of differences in macronutrient composition in Type 2 diabetes nutrition therapy. Despite variations in findings, the Brehm, Gaesser, and Davis studies indicated that health improvements were consistently seen in the results.[7-9] This collective conclusion emphasizes significance on nutrition quality rather than macronutrient composition in Type 2 diabetes nutrition therapy.

Overall Conclusion

The goal of this paper was to see if specific macronutrient compositions in the diet are superior in Type 2 diabetes nutrition therapy through the process of analyzing research regarding this topic. In order to gain a better understanding of the scope of knowledge individuals

diagnosed with diabetes had on healthy eating, a study was conducted by Castetbon and colleagues over dietary behavior exhibited by 45 to 74-year-old individuals diagnosed with diabetes. The Castetbon study found that the individuals diagnosed with diabetes had a more nutritious diet than those not diagnosed, "Overall, 45 to 74-year-old adults with diabetes had a higher-quality diet than individuals without diabetes."[10] The results derived from the collective studies could not concisely pinpoint a conclusion on whether a higher protein, higher fat, or higher carbohydrate diet is superior in Type 2 diabetes nutrition therapy. A consistent outcome in each study was the improvement of overall health in the test participants, including improvements in weight, HDL-cholesterol, insulin sensitivity, and A1C (%). Improvements in anthropometric and metabolic parameters, as well as overall health, were achieved despite the variations of macronutrient composition in the diets the test participants were prescribed.[3-5,7-9] In other words, the quantity of macronutrients consumed is not of significance related to Type 2 diabetes nutrition therapy; instead it is the quality of the macronutrients that is significant, according to the reviewed studies analyzed in this paper. Therefore, there is no optimal macronutrient composition for diet intervention in patients with Type 2 diabetes. Rather, the better diet is the one that the patient can adhere to the most in treatment, as long as the diet meets nutrient recommendations.

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