MACRONUTRIENT INTAKE OF PREGNANT EXERCISERS AND NON-EXERCISERS

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With the childhood obesity pandemic, it is vital for pregnant women to focus on healthy habits (i.e. proper nutrition, exercise) in order to ensure a positive in utero environment. Exercise during pregnancy is associated with normalizing birth weight and decreased body fat of infants. Research of maternal diet finds that increases in maternal consumption of proteins, fats, carbohydrates, and animal and vegetable proteins cause an increase in birth weight. To date, research has not investigated potential differences in nutrition among women that exercise or not during pregnancy.

This research project aims to determine if differences exist in maternal nutrition, more specifically macronutrient intake, related to exercise during pregnancy. Based on previous literature, we hypothesize that pregnant exercisers will have an increased intake of macronutrients (proteins, carbohydrates, fats) compared to pregnant women who do not exercise, but similar frequencies of macronutrients.

Women were either exercise trained (moderate intensity, 50 minutes, 3 times per week) or not (control). All women completed a food frequency questionnaire in the first trimester prior to training and at the end of pregnancy (after 20 week training period). Data from 21 uncomplicated pregnancies was analyzed utilizing t-test for all measures. All women had healthy, singleton pregnancy and delivered healthy infants with normal birth weights. Preliminary findings from this study show there are no group differences in most first trimester macronutrients (protein, carbohydrates, vegetable/fruit, fat/sweet). Preliminary FFQ results show that pregnant women in the exercise group have significantly higher intake of dairy compared to pregnant women that do not exercise during pregnancy. By third trimester, there are no group differences in macronutrient intake of protein, dairy, carbohydrate, vegetables/fruits, and fat/sweets. In addition, gestational weight gain measures show that exercise during pregnancy helps maintain normal weight gain during pregnancy and appropriate birth weight of infants.

These findings suggest all pregnant women obtain similar levels of macronutrients regardless of exercise activity, or not. Although this supports the impact of exercise, and not nutrition per se, on previously beneficial fetal/infant outcomes, further analysis is required regarding quality of macronutrients.

Background

Obesity and childhood obesity, in particular, are major issues in today's society. The problem of childhood obesity has become more prevalent over the last three decades. In the United States, more than one-third of adults have a body mass index (BMI) of 30 or more, characterizing them as obese and 17% of children (ages 2-19) are classified as obese (Ogden 2014). In the state of North Carolina (NC), more than two-thirds of the population is obese. According to the National Survey for Children's Health, 19.3% of the youth of NC are obese and North Carolina is ranked as the 5th highest state for childhood obesity prevalence (NC Division of Public Health 2009). These statistics demonstrate how childhood obesity has become an epidemic in our country. Children that are classified as obese are six times more likely to have an impaired quality of life than children of healthy weights (Schwimmer 2003). It is crucial that we conduct more research dedicated to finding effective ways for combatting childhood obesity.

Early intervention and prevention measures are among the most effective in averting any condition or illness. In regards to childhood obesity, earlier preventative measures. Researchers are now focusing on how mothers can enforce preventative measures during pregnancy, while their children are still in utero. Overall, studies show that it is vital for mothers to maintain healthy habits throughout gestation, as this will foster a healthy environment for fetal development. Two key factors for a healthy pregnancy are maternal diet and exercise.

Many studies focus only on the effects of exercise during pregnancy on infant outcomes. A study performed by Clapp (1996) reports the effects of exercise during pregnancy on infant body composition at five years of age. The study shows that infants of mothers who exercise during pregnancy have lower skinfold measures and tend to weigh less (Clapp 1996); thus suggesting a healthy body composition and less likely to have childhood obesity. Another study performed by Moyer et al. (2015) compares three exercise intervention groups (aerobic, resistance, and circuit training) to a control group and analyzes maternal and fetal measurements, such as fetal morphometric and heart measurements. The findings of this study provide support for the positive influence exercise during pregnancy can have on prevention of chronic diseases (Moyer et al. 2015). In general, recent and previous studies provide evidence of many beneficial infant outcomes for mothers who participate in moderate intensity exercise during pregnancy.

Additional studies focus on the impacts of only nutrition, or the impacts of a healthy diet in combination with exercise, on infant outcomes. Clapp et al. (2008) conducted a study on how maternal diet and exercise affect infant birthweight. Results from Clapp's study reveal that maternal diet composition and weight bearing exercise influence birth weight and fetal fat mass (Clapp et al. 2008). A study by Cuco et al. focuses more closely on nutrition, more specifically maternal intake of macronutrients and its effects on birth weight. The results of this research suggest that a one gram increase in the maternal consumption of proteins, fats, carbohydrates, and animal and vegetable proteins is associated with an increase in birth weight, with proteins having the greatest influence (Cuco et al. 2006). Another study by Clapp (2002) concentrates on the effects of maternal intake of the macronutrient, carbohydrate, on gestational weight gain (GWG). This study shows that consumption of high glycemic carbohydrates causes mothers to have excessive gestational weight gain while consumption of low glycemic carbohydrates leads to moderate birth weight and normal gestational weight gain (Clapp 2002). According to the Chronicle of the Institute of Medicine, physical activity recommendations state that in order to maintain BMI, total energy expenditure needs to account for exercise level (Brooks et al. 2015). These recommendations suggest that pregnant women who exercise should consume more calories than pregnant women who do not exercise. Research shows that quality as well as amount of macronutrient intake may have an impact on the health of mother and infant.

All of the aforementioned studies that focus on maternal diet and exercise suggest that the best infant outcomes result from exercise during pregnancy and increased caloric intake. A few, but not all, of the studies define caloric intake as amount of macronutrients consumed. However, no studies have looked specifically at how macronutrient intake and frequencies of different macronutrients compares among pregnant women who exercise and those who do not.

Study Aim

The purpose of this study was to determine if differences exist in maternal nutrition related to exercise during pregnancy. More specifically, we aimed to look at differences in macronutrient intake among two groups: pregnant exercisers versus pregnant non-exercisers. The macronutrients in question for this study include: proteins, dairy, carbohydrates, fruits/vegetables, and fats/sweets. We hypothesized that pregnant exercisers will have an increased intake of macronutrients compared to pregnant women who do not exercise, but similar frequencies of the types of macronutrients.

Methods

Participants

For this study, participants included twenty-one healthy women from the local area (Greenville, NC). Selected participants had to meet inclusion and exclusion criteria, which are shown by Table 1. The maternal subjects were randomized into one of two groups: exercise-trained or control (CTRL). The exercise-trained group participated in moderate intensity exercise for fifty minutes, three times a week, from 16-36 weeks gestation. For the exercise intervention, moderate intensity is defined as 60% – 80% of their VO_{2max} throughout each exercise session. The control group did not participate in the exercise intervention. All participants were administered a food frequency questionnaire (FFQ) to complete at two time points: during the first trimester, at enrollment, and at the end of their pregnancy (at 36 weeks/delivery).

Data Collection

An appropriate questionnaire is necessary when investigating nutritional issues in mothers (Mouratidou 2006). The FFQ used in our study was found to be valid for use in maternal subjects (Mouratidou 2006). A Likert scale was used in the FFQ to analyze the amount of consumption and intake frequencies of various macronutrients (proteins, carbohydrates, dairy, fruits/vegetables, sweets/fats). As shown in Figure 1, participants choose from 1-5 for various foods and food groups listed in the questionnaire.

We weighed participants with a calibrated, digital scale at 16 weeks and 36 weeks. The difference in weight was used to calculate gestational weight gain (GWG). Birth weight (BW) of newborns was done by standard procedures followed by the labor and delivery nurses of Vidant Medical hospital. Birth Weights were recorded in grams from birth records.

The following questions are about the foods you USUALLY eat.

Circle the how much (on average) that you eat each item.

If you rarely or NEVER eat the food, circle	**1**
If you eat the food once every 2 weeks, circle	**2**
If you eat the food 1-3 times/week, circle	**3**
If you eat the food 4-7 times/week, circle	**4**
If you eat the food more than once a day, circle	**5**

Figure 1. Likert Scale used within the Food Frequency Questionnaire (FFQ)

Data Analysis

A statistical analysis was performed to detect within group and between group differences on quantifiable data from the FFQ results using Student's t-tests and ANOVAS. The Student's t-tests were conducted to determine if there are any significant differences in macronutrient-type intake within the control and exercise-trained group between each time point. A Student's t-test was also utilized to analyze differences in maternal variables among the control and exercise-trained groups at each time point. Statistical significance was set at $\alpha < 0.05$ for all data.

Results

Maternal Variables

Demographic data concerning the twenty-one maternal subjects was collected. The maternal variables measured include: age, height, pre-pregnancy weight, pre-pregnancy BMI, number of pregnancies, and number of children. Pre-pregnancy weight was self-reported by each participant. All of this data is shown in Table 2. Four maternal subjects were in the control group (non-exercisers) and sixteen maternal subjects were in the exercise-trained group. The t-test conducted using this demographic data show that there are no significant differences among maternal variables between the control and exercise-trained group. Unpaired t-tests for each maternal variable resulted in p-values > 0.20. There were no significant differences in education levels between groups.

Macronutrient Intake and Frequency Assessment

For the five macronutrient groups of interest (proteins, dairy, carbohydrates, fruits/vegetables, fats/sweets) t-tests were conducted to compare the two groups (control and exercisers) and the two time points (pre-training and post-training). The resulting data is shown in Table 4. For proteins, carbohydrates, fruits/vegetables, and fats/sweets, there were neither significant between-group differences nor significant between-time point differences (p values >0.10). The analyzed data for these four macronutrients is displayed in the form of bar graphs, which are shown below in Figure 2 and Figure 3.

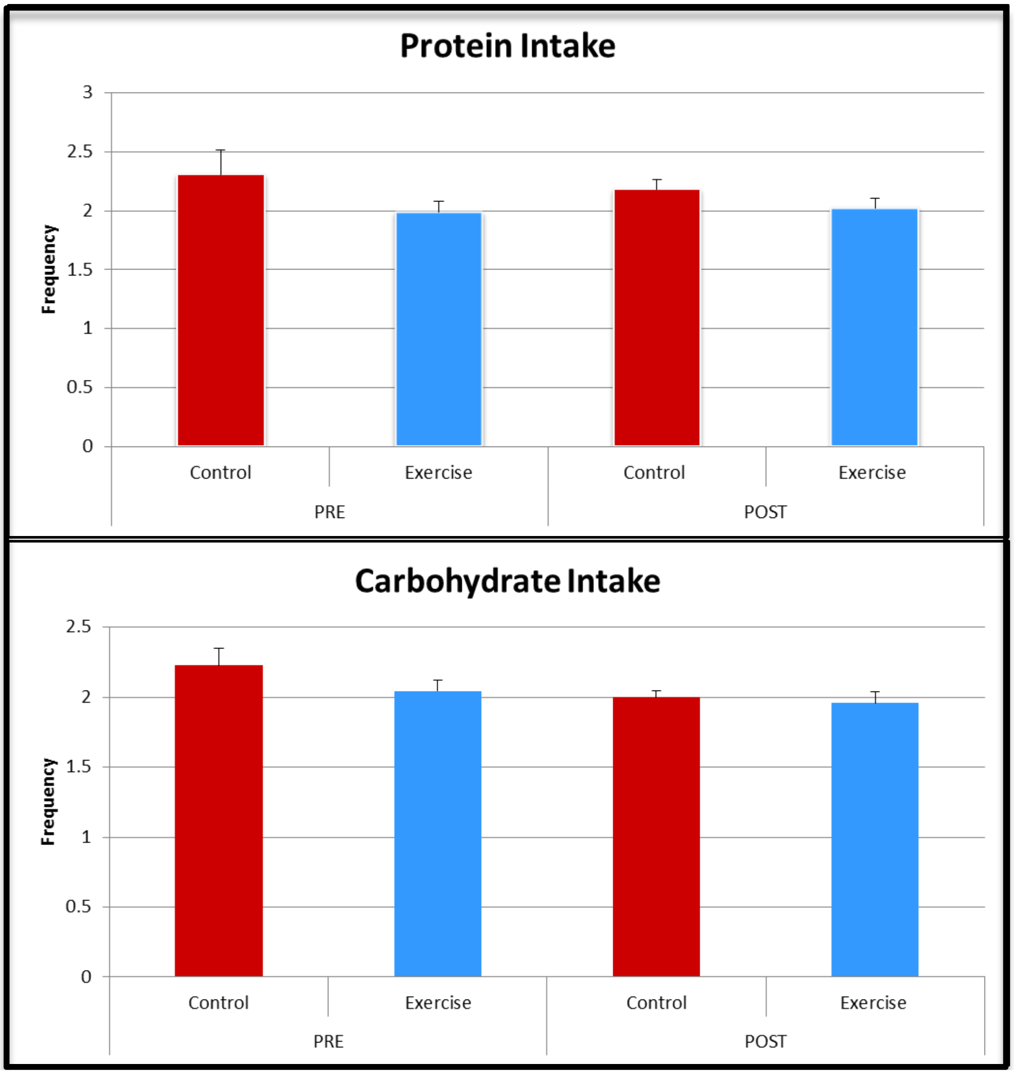

Figure 2. Comparison of Protein intake frequencies between groups and time points (top) and comparison of Carbohydrate intake frequencies between groups and time point (bottom)

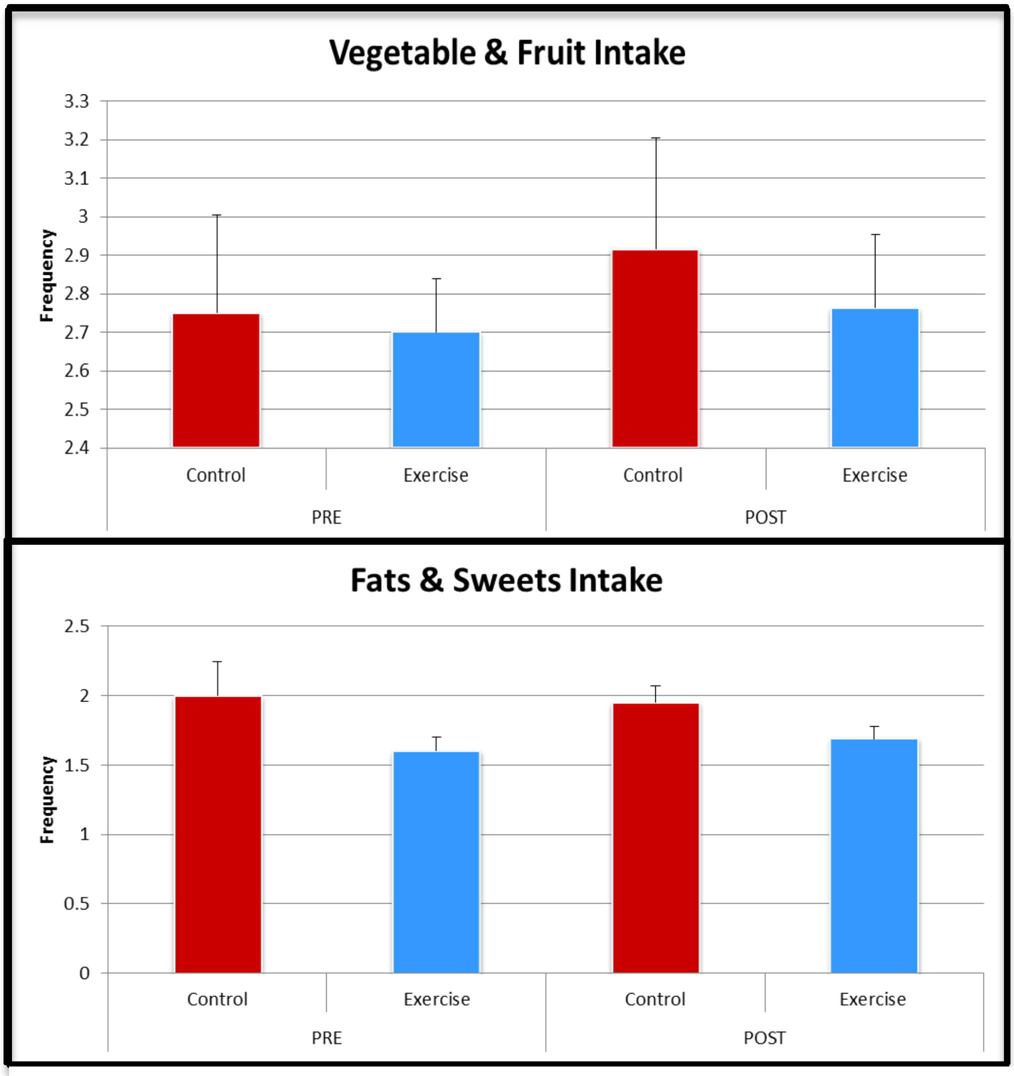

Figure 3. Comparison of Vegetable/Fruit intake frequencies between groups and time points (top) and comparison of Fats/Sweets intake frequencies between groups and time point (bottom)

The analysis of dairy revealed a significant difference ($p = 0.04$) in frequency of dairy intake among control and exercise-trained groups at the pre-training time point (Exercisers mean = 1.84 ± 0.06, CTRL mean = 1.50 ± 0.19) as shown in Figure 4. ANOVA analysis (paired t-test) of pre and post time points revealed a trend toward significant differences ($p = 0.05$) in frequency of dairy intake between the pre and post time points for the control group (Pre-CTRL = 1.50 ± 0.19, Post-CTRL = 1.56 ± 0.28).

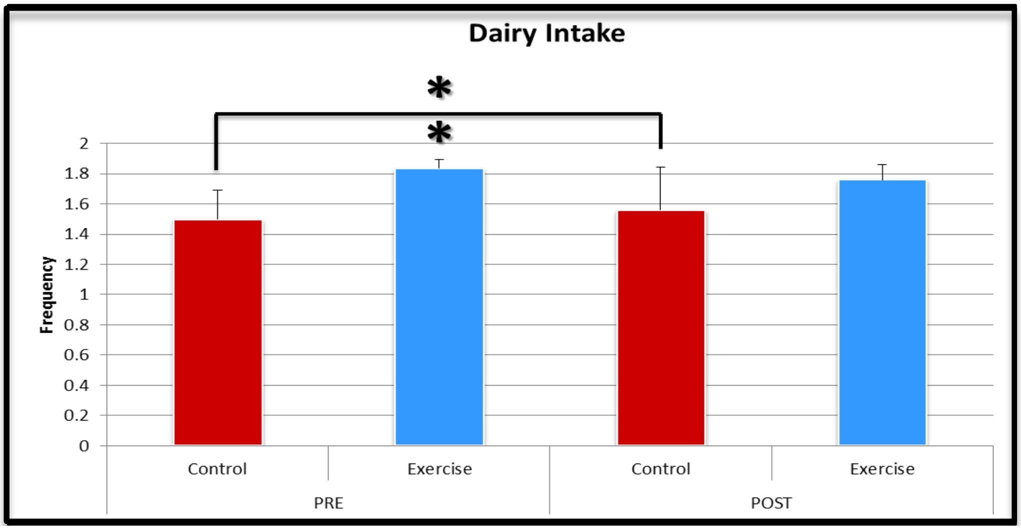

Figure 4. Comparison of Dairy intake frequencies between groups and time points; Sig. diff. between CTRL and exercise at pre-time point and sig. diff. between Pre-CTRL and post-CTRL; *****= p < 0.05

GWG and BW Assessment

Values for gestational weight gain (GWG) and birth weight (BW) for both groups and are shown in Table 3. A t-test performed using this data revealed no differences in GWG or BW between the control group and exercise-trained group.

Discussion

Our findings support the null hypothesis that pregnant exercisers will not have an increase in intake of macronutrients compared to pregnant women who do not exercise. Between pregnant exercisers and non-exercisers (CTRL) there was similar intake of the majority of the macronutrients looked at: proteins, carbohydrates, fruits/vegetables, and fats/sweets. There was a significant difference in carbohydrate intake, in that the control group at the post time point consumed carbs more frequently than the control group at the pre time point. Furthermore, the gestational weight gain and birth weight data provides support for the concept that exercise helps maintain appropriate GWG and BW. No significant difference was found in GWG and BW between the control and exercise-trained group. These findings reveal that the exercise-trained group had adequate macronutrient intake (caloric intake) to support GWG. The pregnant exercisers did not need a greater amount of macronutrients, compared to the non-exercisers, in order to gain weight during pregnancy. Similarly, the infants of exercise-trained mothers did not lack sufficient caloric intake throughout gestation since their mean BW was similar to the mean BW of the control infants. The infants of the exercise-trained women had not adverse outcomes related to growth, since these infants were slightly heavier than the control infants.

Limitations

The major limitation of this study was the small sample size of each group. We will continue to recruit participants in order to increase sample size until statistical power is reached. Exercise adherence may have influenced results, therefore we plan to check training logs to confirm if all exercisers maintained a training frequency of three times per week for at least 90% of the study period. Similarly, although we had participants complete the physical activity questionnaire at the end of the study period, this is via self-report and is subject to bias since we cannot confirm if control group participants refrained from exercise throughout their pregnancy. These aforementioned limitations could have resulted in skewed distinctions of the two groups and therefore, an inability to accurately draw conclusions about each group from the analyzed data. A more accurate daily food log would also enable greater ability to detect specific differences between groups, if any exist.

Conclusion

This study supports the beneficial aspects of exercise during pregnancy on both mother and infant. Even though the mothers who participated in the exercise intervention did not show an increase in intake of macronutrients, they demonstrated GWG and their infants displayed appropriate BW. The pregnant exercisers and non-exercisers were eating similar amounts of macronutrients but the exercisers burned off more calories than the non-active mothers. The exercisers were eating appropriate amounts of macronutrients for the amount of exercise they performed. The non-exercisers were eating excess amounts of macronutrients since they did not participate in exercise to burn off those extra calories. Overall, mothers who regularly participate in moderate intensity exercise will have healthier pregnancies (appropriate GWG) and healthier offspring (appropriate BW). A healthier infant is then more likely to maintain his or her health and develop healthy habits throughout life.

Future research on this topic could be improved upon by having a larger sample size. A larger control group could improve the statistical power of the study and allow for a more realistic view on the differences in macronutrient intake between the control group and exercisers. A more specific food frequency questionnaire would be useful as well. An FFQ that was more of a daily log of what the mothers ate would provide a more accurate representation of macronutrient intake. Quality of macronutrients could also be looked at to see if, for instance, the pregnant exercisers tend to eat more lean proteins or more wheat based carbs than the non-exercisers. As it is now, this study may not provide insight on nutrition during pregnancy but it still provides support for the numerous benefits that exercise during pregnancy has on infant health.

Tables

Table 1: Inclusion and exclusion criteria for maternal subjects

INCLUSION CRITERIA
1. Age: 18 – 40 years
2. BMI: 18.5 – 34.9
3. Pregnancy: Singleton; ≤ 16 weeks gestation
4. Health: Healthy with no chronic illness affecting fetal growth and no use of alcohol, drugs or medications
5. Clearance: Letter from obstetric provider (healthy, no contraindications to exercise)
6. Communication: Fluent in English; available to be contacted via phone and email
EXCLUSION CRITERIA
1. Age: ≤ 17 or ≥ 36 years of age
2. BMI: <18.49 or >35
3. Pregnancy: expecting multiples and/or ≥16 weeks
4. Health: Suffering from any gestational or chronic conditions which may affect fetal development (i.e. diabetes, hypertension, HIV, substance abuse, depression)
5. Taking medicines that are known to affect fetal development and/or pregnancy outcomes
6. Communication: Unable to consent in English and unable to be contacted by telephone/email

Table 2: Maternal participant demographics

MATERNAL VARIABLES	CONTROL	EXERCISERS
Number	4	16
Age (years)	30.1 ± 5.4	30.1 ± 3.0
Height (inches)	66.6 ± 2.7	65.0 ± 2.3
Pre-Pregnancy Weight (lbs.)	160.4 ± 44.7	152.9 ± 35.4
Pre-Pregnancy BMI	25.5 ± 7.5	25.6 ± 5.8
# Pregnancy	1.6 ± 0.7	2.2 ± 1.7
# Children	1.6 ± 0.7	1.9 ± 1.1

Table 3: Gestational weight gain and birth weight values collected

VARIABLE	CONTROL	EXERCISERS
Gestational Weight Gain (lbs)	34.5 ± 9.1	32.9 ± 11.0
Birth Weight (kg)	2.95 ± 0.12	3.39 ± 0.42

Table 4: t-test results; mean frequencies displayed ± standard error measured (SEM) and resulting p-values (statistical significance: $p < 0.05$)

MACRONUTRIENT	TIME POINT	CONTROL	EXERCISE	p-VALUE
Proteins	Pre	2.31 ± 0.21	1.99 ± 0.10	*0.17*
	Post	2.18 ± 0.08	2.02 ± 0.08	*0.38*
Dairy	Pre	1.50 ± 0.19	1.84 ± 0.06	*0.040**
	Post	1.56 ± 0.28	1.76 ± 0.10	*0.43*
Carbohydrates	Pre	2.23 ± 0.12	2.04± 0.08	*0.28*
	Post	2.00 ± 0.05	1.96 ± 0.08	*0.80*
Fruits/Vegetables	Pre	2.75 ± 0.25	2.70 ± 0.14	*0.87*
	Post	2.92 ± 0.29	2.76 ± 0.19	*0.71*
Fats/Sweets	Pre	2.00 ± 0.24	1.60 ± 0.10	0.10
	Post	1.95 ± 0.12	1.69 ± 0.08	0.17

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