Impact of Time Restricted Feeding on Peak Oxygen Uptake and Substrate Utilization

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Abstract

Time Restricted Feeding (TRF) is a type of Intermittent Fasting, which refers to the finite time to intake calories during the day. Partaking in TRF may decease peak volume of oxygen uptake (VO_2peak) due to minimization of glycolytic stores. To date, few studies have compared the impact of TRF on VO_2peak. **PURPOSE:** The current study aimed to further investigate the metabolic impact of TRF. **METHODS:** Thirty-four participants, ages 18-60, completed an eleven-week longitudinal study to examine differences in VO_2peak, substrate utilization crossover, and resting substrate utilization. Participants self-reported diet, exercise, sleep, and medications over two separate four-week periods. The first four weeks were without TRF and the following four were with TRF. A maximal exercise test and a resting metabolic test were performed three times, four weeks apart from each other. A repeated measures ANOVA was performed to determine within subject differences. A post-hoc analysis was performed to determine the time effect. **RESULTS:** VO_2peak was significantly lower after implementing TRF ($p<0.001$). The mean pre-test VO_2peak was 2.95±0.59 L/min and the non-TRF testing was 3.14±0.68 L/min. During TRF, the mean was 2.76±0.54 L/min. There was a significant difference between the pre-test and TRF ($p=0.012$). Also, there was a significant difference between non-TRF and TRF ($p=0.002$). Resting RQ showed a significant increase ($p<0.004$). The pre-test mean for resting RQ was 0.716±0.071. Non-TRF resting RQ had a mean of 0.736±0.082 and the TRF resting RQ was 0.802±0.097. There was a significant difference between the pre-test and TRF ($p=0.010$). Substrate utilization crossover showed a significant decrease ($p<0.03$) in fat usage after TRF implementation. There was a significant difference between the pre-test (123.9±30.1 watts) and TRF (98.8±30.1 watts; $p=0.05$). **CONCLUSION:** An earlier crossover of substrate utilization implies a decrease in fat usage and an increase in carbohydrate usage, therefore significantly lowering fat oxidation and VO2peak. Future studies are needed to examine the physiological mechanisms that may lead to shifts in substrate utilization during TRF.

Introduction

Time Restricted Feeding (TRF) is a form of Intermittent Fasting with a restricted feeding with calorie intake unaffected. Previous research has identified links between diet and oxygen consumption[2]. VO_2peak, peak volume of oxygen consumption, is a variable tested within the current study. VO_2peak may be improved by consuming carbohydrates (CHO) prior to exercise, especially if done a few hours before testing[2] The inability to replenish glycolytic stores may provide evidence that TRF may decrease VO_2peak. RQ, is the volume of carbon dioxide expired over the volume of oxygen inspired and is a type of indirect calorimetry. RQ was another variable measured within the current study. RQ has been shown to change through altered macronutrient intake. Studies indicate a diet high in CHO intake increases RQ, whereas diets high in fat intake have been shown to lower RQ[1]. The purpose of this project was to investigate the impacts of four weeks of TRF on substrate utilization at rest and during maximal exercise. Based on existing literature, it was hypothesized that fat utilization would increase following the four weeks of TRF.

1. McClave et al. (2003). Clinical use of the respiratory quotient obtained from indirect calorimetry. *Journal of Parenteral and Enteral Nutrition banner.* https://doi.org/10.1177/014860710302700121
2. Ormsbee, M. J., Bach, C. W., & Baur, D. A. (2014). Pre-exercise nutrients: The rose of macronutrients, modified starches and supplements on metabolism and endurance performance. *Nutrients, 6,* 1787-1808

Methods

Participants (n=34) were tested in three testing periods over the course of eleven weeks. Participants were provided daily logs to self-report caloric intake within a 9-hour window and exercise each day. VO_2 testing was done using a cycle ergometer (Lode, Corival, Groningen, The Netherlands) and a metabolic cart (TrueOne 2400, ParvoMedics, Parvo, UT). For each test, participants were fitted with a heart rate monitor, and a mouthpiece attached to a metabolic cart by a tube to record data. A nose plug was worn ensure all inspired and expired air went through the mouth. The test was done in 2-minute stages, starting at 50 W and increased by 25 W every stage. The pedaling rate remained between 60-70 RPM throughout the test. Data collected included BP, HR, VO_2, VCO_2, RPE, RER, and VE.

Results

There was a significant decrease between non-TRF (3.14±0.68) and TRF (2.76±0.54) testing periods in VO_2peak, with a p-value of 0.001. There was no significant difference in wattage, implying that participants made it to the same wattage each test. There was a significant decrease in the substrate crossover points between all three testing points. Pre-test (123.8±30.1), non-TRF (116.7±39.0), and TRF (98.8±30.1) had a p-value of 0.03.
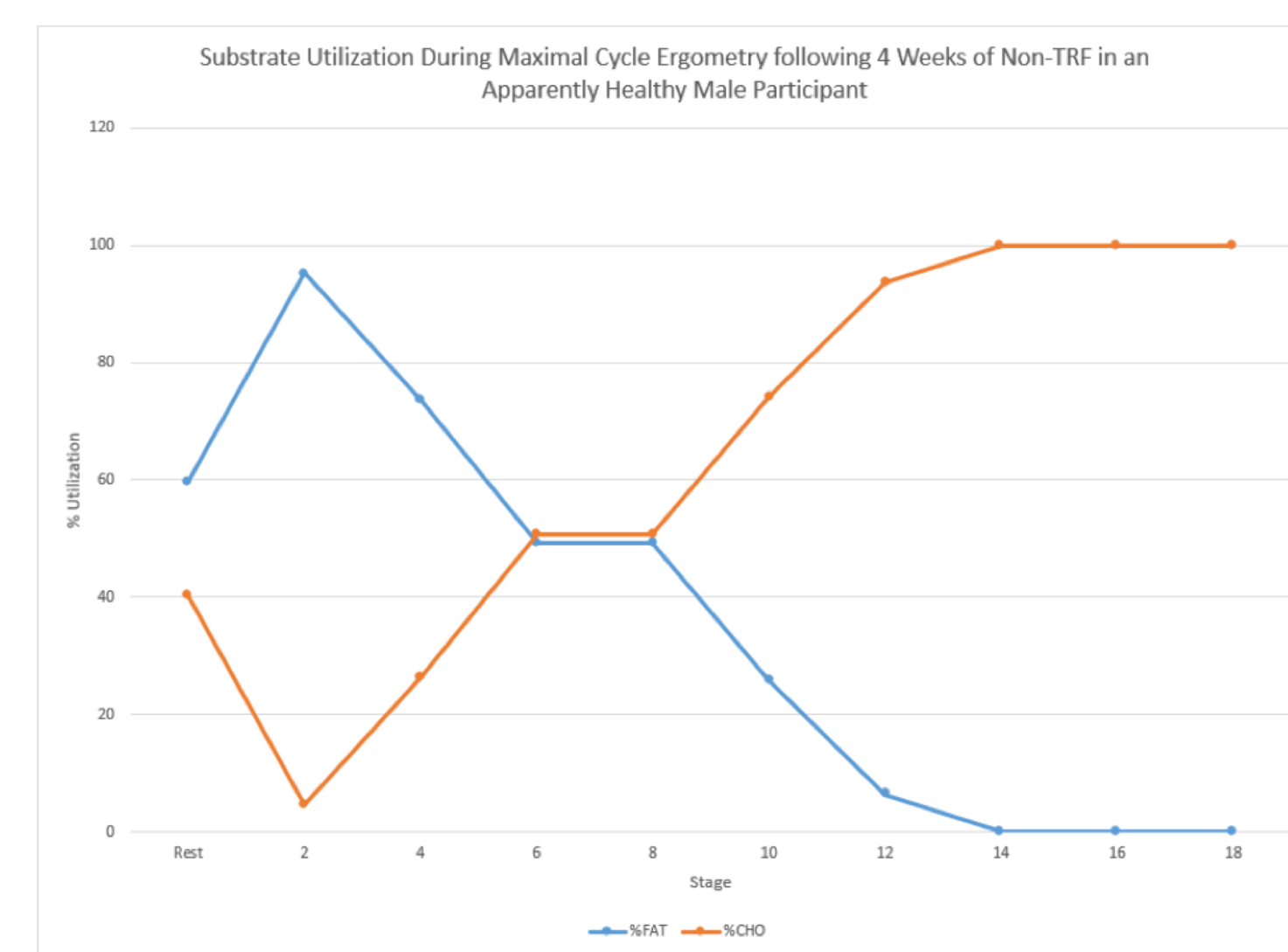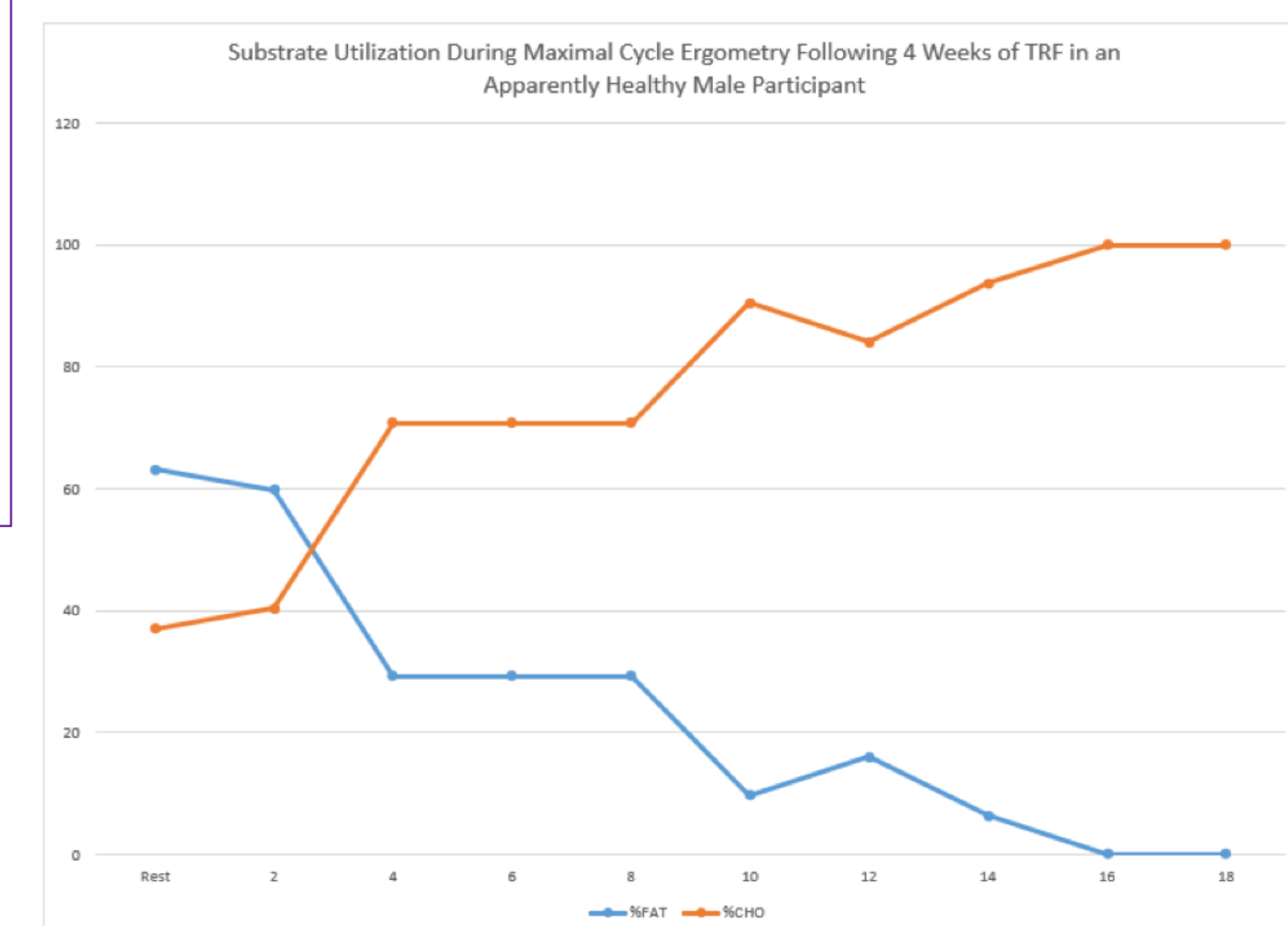
Conclusion

The significant decrease found in the VO_2peak and in the substrate utilization are assumed to be linked. Since the crossover point occurs sooner after TRF, the body changes the substrate and metabolic system that is utilized for a longer portion of the test. Based on the results of this study, the first four weeks of TRF may cause an increased reliance on carbohydrates as a substrate. While this is contrary to previous studies, the duration of this study was shorter than the previous research reviewed.

Table 1. Peak and resting physiological variables at three time intervals (mean ± standard deviation)

Variable	Pre-test N=34	Non-TRF N=32	TRF N=21	p-value
VO_2peak (L/min)	2.95±0.59	3.14±0.68	2.76±0.54	0.001*
HRpeak(bpm)	177.9±17.6	178.4±11.6	176.5±10.5	0.779
Peak Workload(W)	190.5±31.1	178.5±39.8	185.7±34.9	0.166
Exercise RQ	1.06±0.04	1.95±4.01	1.07±0.04	0.285
VE (L/min)	72.6±19.00	81.17±19.02	66.52±15.94	0.211
REE (kcals/day)	2048.7±387.8	2199.5±469.0	2069.9±485.7	0.233
Resting RQ	0.716±0.071	0.736±0.082	0.802±0.097	0.004*
Substrate Crossover Point (W)	123.8±30.1	116.7±39.0	98.8±30.1	0.03*

* represents a significant difference in the data over the three time periods.

Substrate Utilization During Maximal Cycle Ergometry Following 4 Weeks of TRF in an Apparently Healthy Male Participant

Substrate Utilization During Maximal Cycle Ergometry following 4 Weeks of Non-TRF in an Apparently Healthy Male Participant

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