Substrate metabolism at rest and during steady-state cycling following four weeks of n-3 PUFA supplementation

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ABSRACT

Omega-3 polyunsaturated fatty acids (n-3 PUFA) can mediate numerous biological processes, including changing skeletal muscle membrane composition. Given the metabolic role of skeletal muscle, n-3 PUFA supplementation may influence fuel metabolism at rest and/or during exercise. Purpose. This study aimed to investigate the effects of n-3 PUFA supplementation both at rest and during steady-state exercise in endurance-trained individuals. Methods. Twenty-one male cyclists and triathletes underwent two experimental trials separated by four weeks. During this period participants were supplemented twice daily with a juice based drink containing fish oil with 2 g EPA and 2 g DHA, or a taste-matched control drink containing no fish oil. During the experimental trials, expired gas was collected at rest and during 60 minutes of cycling at 85% of the individual lactate threshold. Results. n-3 PUFA supplementation significantly increased RER when compared to the control (Δ +0.04 ± 0.03 compared to Δ +0.01 ± 0.02, $p<0.05$) and also increased CHO oxidation (Δ +0.41 ± 0.32 g·min^{-1} compared to Δ +0.05 ± 0.30 g·min^{-1} $p<0.05$) during steady-state exercise; however no differences were observed at rest. There also was a reduction in fat oxidation during exercise following n-3 PUFA supplementation ($p<0.05$). Conclusion. Our results indicate that n-3 PUFA supplementation may potentiate a shift in fuel utilization to carbohydrate oxidation during steady-state exercise in endurance-trained cyclists.

INTRODUCTION

1. n-3 PUFAs mediate a number of different biological roles such as metabolism and therefore may alter substrate storage and oxidation.
2. Improved insulin sensitivity (Tsitouras *et al.,* 2008) and glucose storage (Stephens *et al.,* 2014) has been observed with an uptake of n-3 PUFAs into cell membranes of various tissues.
3. In a glucose fed state, n-3 PUFA supplementation has improved metabolic flexibility, and reduced fatty acid oxidation. Whereas in a fasted state human myotubes have shown an increase in fat oxidation (Hessvik *et al.,* 2010).
4. On this basis, it is possible that n-3 PUFA may regulate substrate use at rest and during exercise differently in the fasted state.

AIM

To investigate the effect of n-3 PUFA supplementation on substrate utilisation at rest and during exercise in endurance-trained individuals.

METHODS

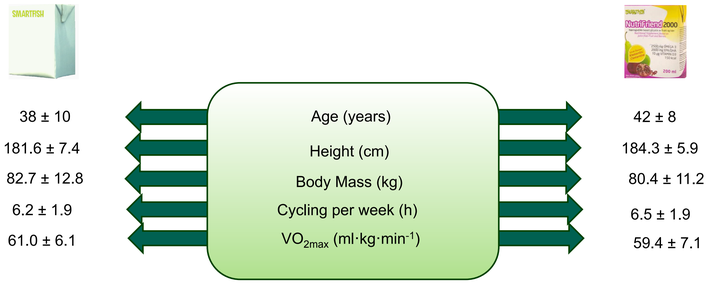

Figure 1 – Participant characteristics in both the FO and control group.

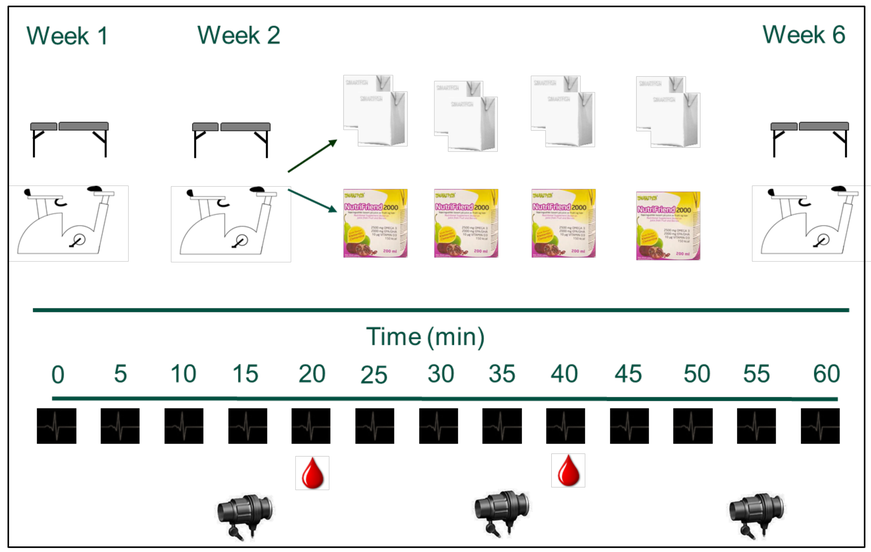

Figure 2 – Schematic representation of experimental protocol. Measurements of indirect calorimetry before and after a 4 wk supplementation of either n-3PUFA or a control supplement.

RESULTS

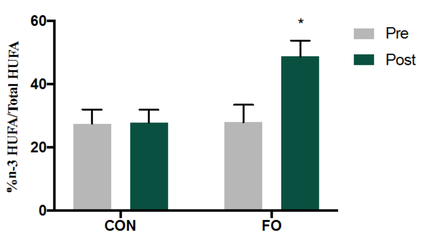

Figure 3 – Percentage of n-3 PUFA/Total PUFA composition in blood before and after 4 wk supplementation. Data expressed as means ± SD. * Significantly different from Pre.

	CON	FO
Body mass (Pre) (kg)	82.7 ± 12.8	80.4 ± 11.2
Body mass (Post) (kg)	83.2 ± 12.8	81.7 ± 11.5 *
Sum of skinfolds (Pre) (mm)	80.0 ± 20.5	65.8 ± 30.4
Sum of skinfolds (Post) (mm)	79.8 ± 19.9	69.5 ± 28.7
Energy intake (kcal·d^{-1})	2668 ± 811	2816 ± 76
CHO intake (g·d^{-1})	321 ± 101	360 ± 134
Protein intake (g·d^{-1})	110 ± 32	87 ± 25
Fat intake (g·d^{-1})	108 ± 30	97 ± 37

Table 1 – Body mass, skinfold measurements and habitual dietary intake of the participants in both the CON and FO groups. Data expressed as means ± SD. * Significantly different from Pre.

Figure 4

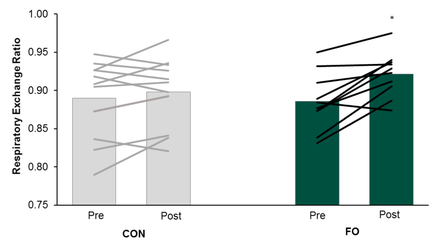

Figure 5

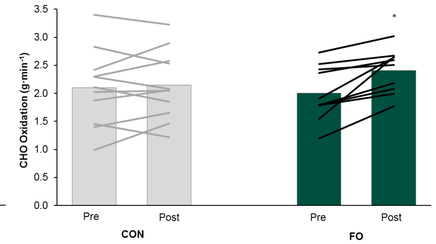

Figure 4 - Respiratory Exchange Ratio during exercise Pre and Post supplementation. *Significant difference in Pre to Post changes between Fish Oil group (FO) and Control group (CON). Values are presented as means ± SD.

Figure 5 - Carbohydrate (CHO) oxidation rates Pre and Post supplementation. *Significant difference in Pre to Post changes between Fish Oil group (FO) and Control group (CON) ($p<0.05$). Values are presented as mean ± SD.

Figure 6

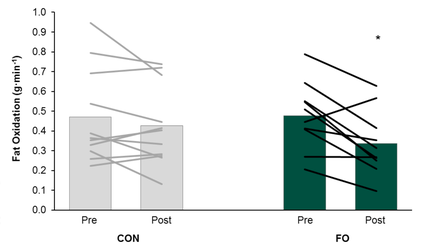

Figure 6 - Fat oxidation rates during exercise Pre and Post supplementation. *Significant difference in Pre to Post changes between Fish Oil group (FO) and Control group (CON) ($p<0.05$). Values are presented as mean ± SD.

DISCUSSION

1. Our findings are generally contradictory to previous research.
2. Previous literature has not found any changes in RER at rest with previous literature. However, a larger dose and longer duration supplementation of n-3 PUFAs may explain the differences in findings.
3. We speculate that an increase in body mass with n-3 PUFA supplementation may be due to an increase in glycogen storage.
4. Future research should examine the effects of glycogen storage following n-3 PUFA supplementation.

CONCLUSIONS

Supplementation of 4g·d^{-1} of n-3 PUFAs over a 4 week period increases respiratory exchange ratio and carbohydrate oxidation as well as decreasing fat oxidation during steady- state cycling.

We would like to thank Smartfish nutrition Ltd. for providing the supplements for this project.

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