The influence of dietary fish oil and exercise upon oxidative status biomarkers in a rat model

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Introduction. Oxidative stress is implicated in cardiovascular and many other diseases, as well as in normal aging. Highly unsaturated omega-3 fatty acids are very susceptible to oxidation and the generation of reactive oxygen species while intense exercise promotes an environment for increased oxidation. Paradoxically, both chronic dietary fish oil consumption and chronic exercise are associated with reduced cardiovascular disease morbidity and mortality.

Objective. This study aimed to determine the effect of dietary fish oil and exercise training on membrane fatty acid composition and biomarkers of oxidative stress in tissues representative of different levels of oxidation.

Methods. Male Wistar rats, fed either saturated fat (SF) or fish oil (FO) diets for 6 weeks were exercise trained (weighted swimming, 1h/d, 5d/w with 2% body weight on tail) or remained sedentary. Rats rested for 2 days and fasted overnight were anaesthetised (pentobarbitone sodium 60mg/kg i.p) and killed by rapid exsanguination. Liver and skeletal muscles (diaphragm, abdominal sheath and white vastus lateralis) were analysed for membrane fatty acids, lipid peroxidation products and endogenous antioxidants: glutathione peroxidase and superoxide dismuatse.

Outcomes. In all tissues FO feeding increased EPA, DHA, total n-3 PUFA and the unsaturation index and decreased arachidonic acid, total n-6 PUFA and n-6/n-3 ratio ($p<0.05$). Exercise training increased membrane arachidonic acid ($p=0.023$) in the FO liver but decreased DHA($p=0.002$) and total n-3 PUFA ($p=0.017$) compared to FO sedentary. The liver compared to muscle tissue and diaphragm compared to other muscles had higher membrane arachidonic acid (AA) and lower DHA content. Lipid hydroperoxidation varied according to tissue phospholipid unsaturation but there was no additional effect of fish oil consumption or exercise training. Activities of glutathione peroxidase and superoxide dismutase varied according to tissue metabolic activity (liver >> muscle (diaphragm > abdominal muscle)) with no additional effect of fish oil consumption or exercise training.

Conclusion. Fatty acid composition and antioxidant enzyme activity may be related to the oxidative functions of different tissues. Despite incorporation of n-3 PUFA into cell membranes, fish oil feeding did not increase tissue oxidative stress measured at rest and exercise training was not associated with altered oxidative stress biomarkers at rest.