Protective Effect of Fish Oil Supplementation on Exercise-Induced Bronchoconstriction in Asthma

Chest

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Abbreviations:
AA = arachidonic acid
DHA = docosahexanoic acid
EPA = eicosapentaenoic acid
LA = linoleic acid
PUFA = polyunsaturated fatty acid

FROM ABSTRACT:

Background:
Previous research has demonstrated that fish oil supplementation has a protective effect on exercise-induced bronchoconstriction in elite athletes, which may be attributed to its antiinflammatory properties.

Since exercise-induced bronchoconstriction in asthma involves proinflammatory mediator release, it is feasible that fish oil supplementation may reduce the severity of exercise-induced bronchoconstriction in asthmatic subjects.

Study objectives: To determine the efficacy of fish oil supplementation on severity of exercise-induced bronchoconstriction in subjects with asthma.

Design: Randomized, double-blind, crossover study.

Setting: Lung function and exercise testing in a university research laboratory.

Patients and measurements:
Sixteen asthmatic patients with documented exercise-induced bronchoconstriction entered the study on their normal diet and then received either fish oil capsules containing 3.2 g of eicosapentaenoic acid and 2.0 g of docosahexanoic acid (fish oil diet, n = 8) or placebo capsules (placebo diet, n = 8) daily for 3 weeks.

At the beginning of the study (normal diet) and at the end of each treatment phase, the following pre-exercise and postexercise measures were assessed:
1) Pulmonary function.
2) Induced sputum differential cell count percentage and proinflammatory eicosanoid metabolites (leukotrienes and prostaglandins) and cytokine (interleukin 1β and tumor necrosis factor) concentrations.
3) Eicosanoid metabolites leukotriene B4 and leukotriene B5 generation from activated polymorphonuclear leukocytes.

Results: On the normal and placebo diet, subjects exhibited exercise-induced bronchoconstriction.

However, the fish oil diet improved pulmonary function to below the diagnostic exercise-induced bronchoconstriction threshold, with a concurrent reduction in bronchodilator use.

Concentrations of proinflammatory leukotrienes, prostaglandins, and cytokines were significantly reduced before and following exercise on the fish oil diet compared to the normal and placebo diets.

Conclusion:
Our data suggest that fish oil supplementation may represent a potentially beneficial nonpharmacologic intervention for asthmatic subjects with exercise-induced bronchoconstriction.

THESE AUTHORS ALSO NOTE:

Exercise-induced bronchoconstriction is the transient narrowing of the airways following exercise, resulting in a post-exercise decrement in lung function.

Exercise induced transient dehydration “activates proinflammatory mediators, such as histamine and the arachidonic acid (AA) metabolites leukotrienes and prostaglandins from resident airway cells, resulting in bronchial smooth-muscle contraction and subsequent airway obstruction.”

“There is accumulating evidence that dietary modification has potential to reduce the prevalence and incidence of asthma and exercise-induced bronchoconstriction.”

A contributing factor to the increased incidence of asthma in Western societies is the consumption of a proinflammatory diet:
1) “In the typical Western diet, 20-fold to 25-fold more omega (n)-6 polyunsaturated fatty acids (PUFAs) than n-3 PUFAs are consumed, which results in the release of proinflammatory AA metabolites.”
2) “Eicosapentaenoic acid (EPA) and docosahexanoic acid (DHA) are n-3 PUFAs derived from fish oil that competitively inhibit n-6 PUFA AA metabolism and thus reduce the generation of proinflammatory four-series leukotrienes and two-series prostaglandins and production of cytokines from inflammatory cells.”
3) Since asthma and exercise-induced bronchoconstriction are both mediator-driven inflammatory processes, the high content of EPA and DHA found in fish oil might reduce airway inflammation.
“Thus, fish oil supplementation may prove to be a useful intervention for primary prevention of exercise-induced bronchoconstriction.”

Prior studies have shown that in elite athletes with exercise-induced bronchoconstriction, supplementing the diet with 5.5 g of fish oil for 3 weeks reduced bronchodilator use and resulted in a significant suppression of proinflammatory prostaglandin and leukotriene eicosanoids.

STUDY RESULTS:

“Bronchodilator use (total number of doses/puffs) was significantly reduced during the last 2 weeks of the fish oil diet compared to the normal diet and placebo diet.”

“The fish oil diet induced a significant reduction in the percentage of eosinophils, neutrophils, and a significant increase in the percentage of macrophages, compared to the placebo and normal diets.”

Fish oil supplementation resulted in significant reduction of proinflammatory eicosanoids [such as prostaglandins and leukotrienes] compared to the placebo and normal diets.

“Following fish oil supplementation the neutrophil phospholipid content of EPA and DHA significantly increased, while the neutrophil phospholipid content of linoleic acid (LA) [plant derived omega-6 fat] and arachidonic acid (AA) [animal derived omega-6 fat] was significantly reduced.”

DISCUSSION:

“This study has demonstrated that a diet supplemented with fish oil ameliorates the severity of exercise-induced airway narrowing in subjects with mild-to-moderate persistent asthma.”

The fish oil diet improved pulmonary function and this “improvement in postexercise pulmonary function on the fish oil diet was accompanied by a more than 31% reduction in bronchodilator use.”

“A diet supplemented with fish oil reduces airway inflammation in asthmatic subjects with exercise-induced bronchoconstriction.”

“Dietary enrichment with 3.2 g of EPA and 2.0 g of DHA caused a significant increase in the EPA and DHA content and a reduction of AA and LA content of neutrophil phospholipid in the asthmatic subjects.”

“EPA and DHA, derived from fish oil, can cause dual inhibition of cyclooxygenase-2 and 5-lipoxygenase pathways for metabolism of AA.”
EPA inhibits release of AA-derived eicosanoids, thus reducing the generation of proinflammatory series 4 leukotrienes and series 2 prostaglandins.

"Consuming fish oil results in partial replacement of AA in inflammatory cell membranes by EPA and thus demonstrates a beneficial antiinflammatory effect of n-3 PUFA."

"Fish oil supplementation suppresses mast-cell activation in subjects with exercise-induced bronchoconstriction."

Other studies have shown significant improvements in asthma symptoms following fish oil supplementation.

"In summary, this study has shown that fish oil supplementation may represent a potentially beneficial nonpharmacologic intervention in asthmatic patients with exercise-induced bronchoconstriction."

"The fish oil diet reduced airway inflammation and the severity of exercise-induced bronchoconstriction with a concomitant decrease in bronchodilator use."

KEY POINTS FROM DAN MURPHY

1) Fish oil supplementation has a protective effect on exercise-induced bronchoconstriction in elite athletes, attributable to its antiinflammatory properties.

2) This study used 5.2 g of fish oil per day.

3) 3 weeks of fish oil diet improved pulmonary function and reduced bronchodilator use.

4) Fish oil supplementation is a beneficial nonpharmacologic intervention for asthmatic subjects with exercise-induced bronchoconstriction.

5) Arachidonic acid metabolites leukotrienes and prostaglandins are proinflammatory mediators that cause bronchial smooth-muscle contraction and subsequent airway obstruction and asthma.

6) "In the typical Western diet, 20-fold to 25-fold more omega-6 fatty acids than omega-3 fatty acids are consumed, which results in the release of proinflammatory arachidonic acid metabolites."

7) "Eicosapentaenoic acid (EPA) and docosahexanoic acid (DHA) are omega-3 fatty acids derived from fish oil that competitively inhibit omega-6 fatty acid arachidonic acid metabolism and thus reduce the generation of proinflammatory four-series leukotrienes and two-series prostaglandins and production of cytokines from inflammatory cells."
8) Asthma and exercise-induced bronchoconstriction are both inflammatory processes, and the high content of EPA and DHA found in fish oil reduces airway inflammation.

9) Fish oil supplementation is a useful intervention for primary prevention of exercise-induced bronchoconstriction.

10) Bronchodilator use (total number of doses/puffs) was significantly reduced in the fish oil diet compared to the normal diet and placebo diet.

11) Fish oil supplementation resulted in significant reduction of proinflammatory eicosanoids [such as prostaglandins and leukotrienes] compared to the placebo and normal diets.

12) “A diet supplemented with fish oil ameliorates the severity of exercise-induced airway narrowing in subjects with mild-to-moderate persistent asthma.”

13) The fish oil diet improved pulmonary function and this “improvement in postexercise pulmonary function on the fish oil diet was accompanied by a more than 31% reduction in bronchodilator use.”

14) “A diet supplemented with fish oil reduces airway inflammation in asthmatic subjects with exercise-induced bronchoconstriction.”

15) “The fish oil diet reduced airway inflammation and the severity of exercise-induced bronchoconstriction with a concomitant decrease in bronchodilator use.”

SEE SUMMARY BELOW
Proinflammatory Eicosanoids and Asthma

Linoleic Acid
Plant Derived Omega-6 Fatty Acids
Canola, Corn, Cottonseed, Peanut, Safflower, Sunflower, Soybean

Arachidonic Acid
Animal (primarily meat) Derived Omega-6 Fatty Acid

Proinflammatory Series 2 Prostaglandins (Eicosanoids)

Proinflammatory Series 4 Leukotrienes (Eicosanoids)

BOTH Series 2 Prostaglandins and Series 4 Leukotrienes Cause Bronchial-Inflammation AND Bronchoconstriction Resulting In Asthma

The Omega-3 Fatty Acids

Eicosapentaenoic Acid AND Docosahexanoic Acid Inhibit The Conversion Of Arachidonic Acid INTO Series 2 Prostaglandins AND Series 4 Leukotrienes

“In the typical Western diet, 20-fold to 25-fold more omega-6 fatty acids than omega-3 fatty acids are consumed, which results in the release of proinflammatory Arachidonic Acid metabolites.”

“Eicosapentaenoic acid (EPA) and docosahexanoic acid (DHA) are omega-3 fatty acids derived from fish oil that competitively inhibit omega-6 fatty acid Arachidonic Acid metabolism and thus reduce the generation of proinflammatory four-series leukotrienes and two-series prostaglandins and production of cytokines from inflammatory cells.”