THE ROLE OF DIETARY FATTY ACIDS IN ASTHMA

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Asthma is...
a chronic inflammatory disorder of the airways in which many cells and cellular elements play a role.

Inflammation occurs in asthma because...
asthmatics exhibit an exaggerated immune response to stimuli (e.g. allergens and viruses).

Chronically inflamed airways become hyperresponsive,
obstructed and have limited airflow, leading to recurrent episodes of wheezing, breathlessness, chest tightness and coughing.
Effects of Inflammation in Asthma

Air enters respiratory tract via mouth and nose and enters bronchial tubes

Smooth muscle thickens, contracts and becomes hyperresponsive

Damage to airway epithelium

Excess mucus

ASTHMA: Inflamed bronchial tube

NORMAL bronchial tube
Global Burden of Asthma

- Affects 300 million people worldwide
- Prevalence: increased over time, higher in Westernised countries
- Migration to Western countries can lead to development of asthma
Factors Leading to Development and Expression of Asthma

Host Factors:
- Genetic
- Sex

Environmental:
- Allergens: Indoor (dust mites, dogs, cats, cockroaches)
  Outdoors (pollens, moulds, fungi, yeasts)
- Infections (early childhood)
- Occupational exposure
- Smoking (active/ passive)
- Diet (nutrient intake/ obesity)
A western diet – fuel for inflammation?

Western-style fast food increases asthma risk
(Hijazi, 2000; Wickens 2005; Nagel 2010; Huang 2001; Carey 1996)

Chronic ‘metabolic surplus’ (→ Obesity)
Low antioxidant intake:
  Increased use of processed foods
  Low fruit, vegetable, whole grain intake
Altered fatty acid profile:
  Low omega-3:omega-6 fatty acid ratio
  Low monounsaturated fat intake
  Higher %saturated fat
  Trans fats
Fatty acids – fuel for inflammation?

- SFA activate TLR2, TLR4, transforming growth factor-β–activated kinase-1 (TAK1) and TAK1-binding protein-1 (TAB1) associate, IKK and JNK are activated, causing increased transcription of inflammatory genes.

- Omega-3 FA activate GPR120 inhibits TAK1 activation and inflammatory signalling.

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Omega-3 fatty acids
Omega-3 fatty acids and asthma: evidence to date

- Omega-3 fatty acid or fish intake is associated with improved lung function, decreased asthma risk, AHR, wheeze (Schwartz, 94, 2000; Yu, 1996)
- Omega-6/omega-3 ratio associated with asthma risk (Newson, ‘04)

- Data is heterogeneous, some studies show no effect

- Supplementation studies inconclusive (Cochrane, 2001)
Omega-3 fatty acids: protect against asthma triggers:

Murine and Cell Culture models
Study: Virus Infection

Method:

- Time 0
- Omega-3 FA added to confluent CALU-3 epithelial cells
- Cells infected with RV
- 24 hr
- Media removed
- Media collected for analysis of inflammatory cytokines
- 72 hr

(Saedisomeolia, Wood et al, J Nutr Biochem, 2009)
Study: Virus Infection

Results:

(Saedisomeolia, Wood et al, Brit J Nutr, 2009)
Study: Virus Infection

Results:

DHA reduces inflammatory response to rhinovirus infection

(Saedisomeolia, Wood et al, Brit J Nutr, 2009)
Study: Allergen Exposure

Method:

- day -14
  - Commence daily omega-3FA supplementation (200µL)
  - Mussel extract (11% ω-3)
  - or fish oil (30% ω-3)

- 0
  - ip OVA
  - Mice were sensitized by intraperitoneal (ip) injection of 50 µg of OVA

- 12 13 14 15 16
  - in OVA
  - Mice were challenged by intranasal (in) instillation of 10 µg of OVA

(Wood et al, 2010, Clin Exp Allergy)
Study: Allergen Exposure

Results:

(Wood et al, 2010, Clin Exp Allergy)
Study: Allergen Exposure

Results:

Mussel extract reduced inflammatory response to allergen and reduced airway hyperresponsiveness

(Wood et al, 2010, Clin Exp Allergy)
Saturated fatty acids
Saturated fatty acids: TLR4 activation
**Study: Dietary Fat Challenge**

**Aim:**
To examine the effect of high fat meal on airway inflammation in asthma

**Method:**
- Stable asthmatics (n=51): fasted, medications withheld
- High or low fat meal then bronchodilator
- Airway inflammation (0, 4 hr) and lung function (0,2,3,4 hr)

(Wood et al, J Allergy Clin Immunol, 2011)
Study: Dietary Fat Challenge

Results:

Dietary fat and airway inflammation at 4 hrs

(Wood et al, J Allergy Clin Immunol, 2011)
Study: Dietary Fat Challenge

Results:

Bronchodilator response at 4 hrs

*\(p<0.05,\) AHF vs ALF

(Wood et al, JACI, 2011)
Summary/ Conclusion

- Dietary fat intake may modify asthma outcomes.
- Omega-3 fatty acids reduce inflammatory response to common triggers - virus infection and allergy.
- High fat intake (saturated fat/ omega-6 PUFA) worsens airway inflammation and bronchodilator responses.
- Dietary fat intake affects the airways. Strategies aimed at modulating fat intake should be explored.
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