

Childhood Asthma, Obesity and Western Diet: Complex interactions and possible solutions

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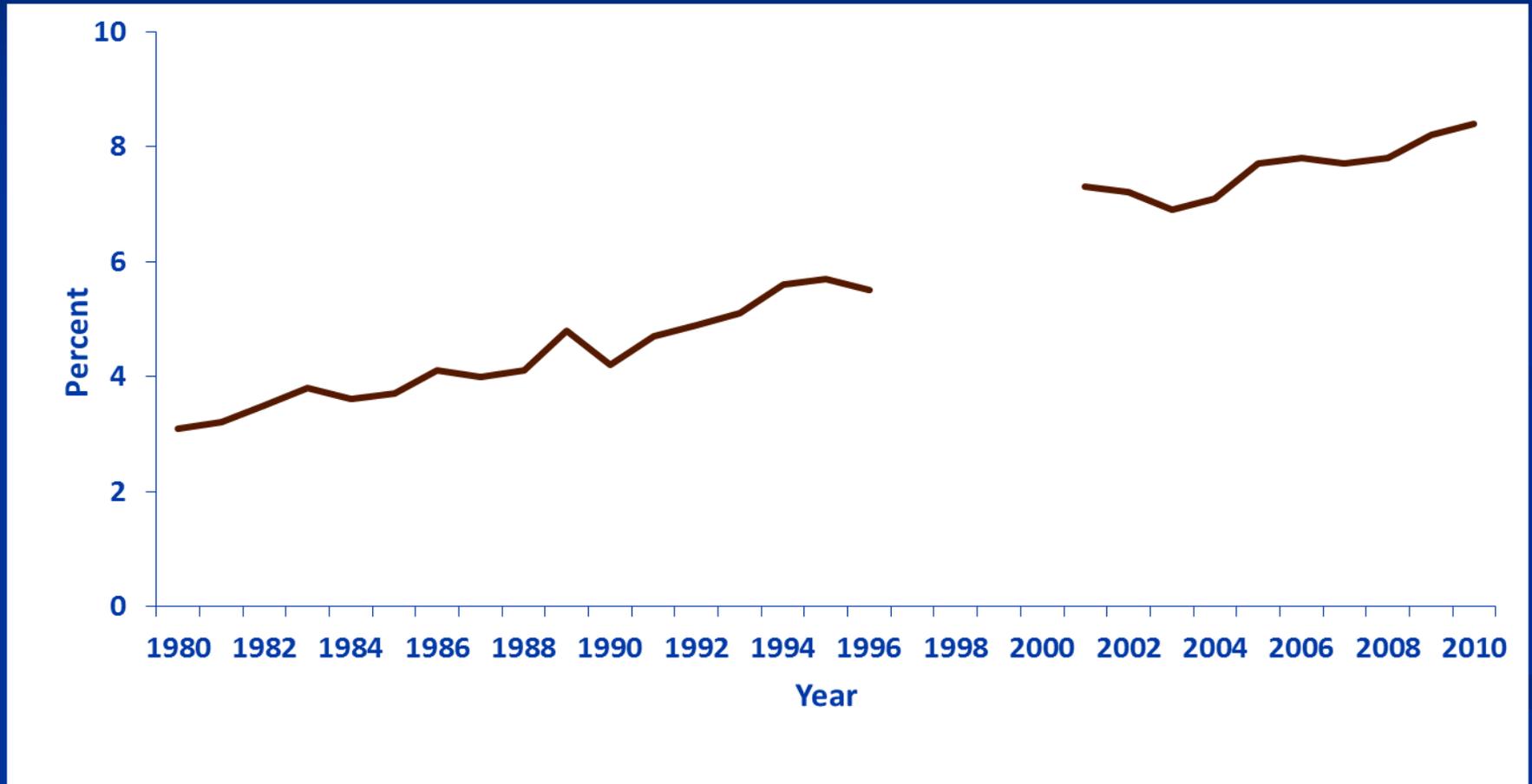
Center for Childhood Asthma in the Urban Environment

Funding since 1998 by:

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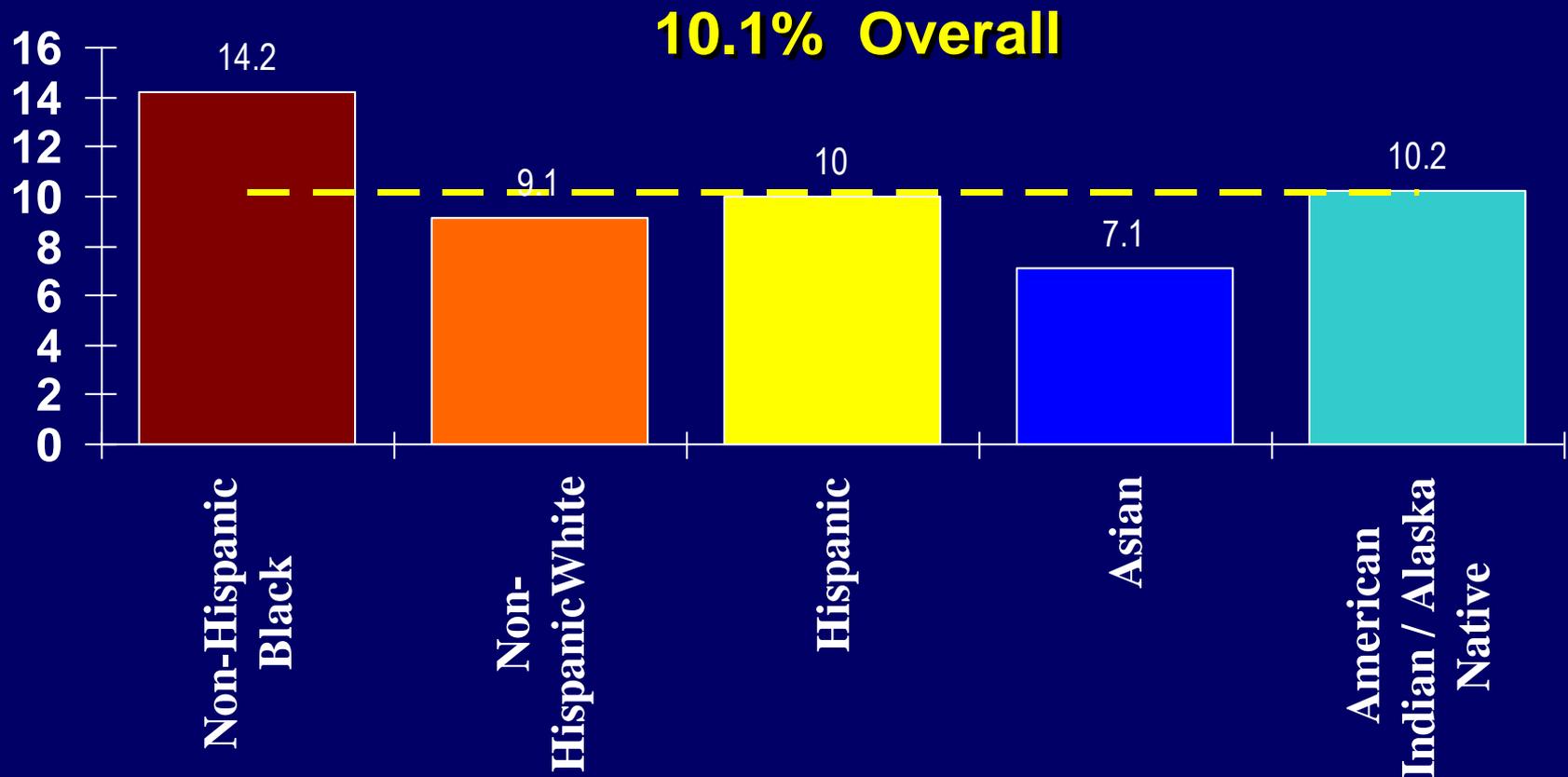
EPA

Asthma Prevalence in the U.S. 1980-2010



The percentage of the U.S. population with asthma increased from 3.1% in 1980 to 5.5% in 1996 and 7.3% in 2001 to 8.4% in 2010.

Current Asthma Prevalence for Youth by Race/Ethnicity, Ages 5-17, 2005-2007



Many Factors Coalesce Unfavorably in Inner City

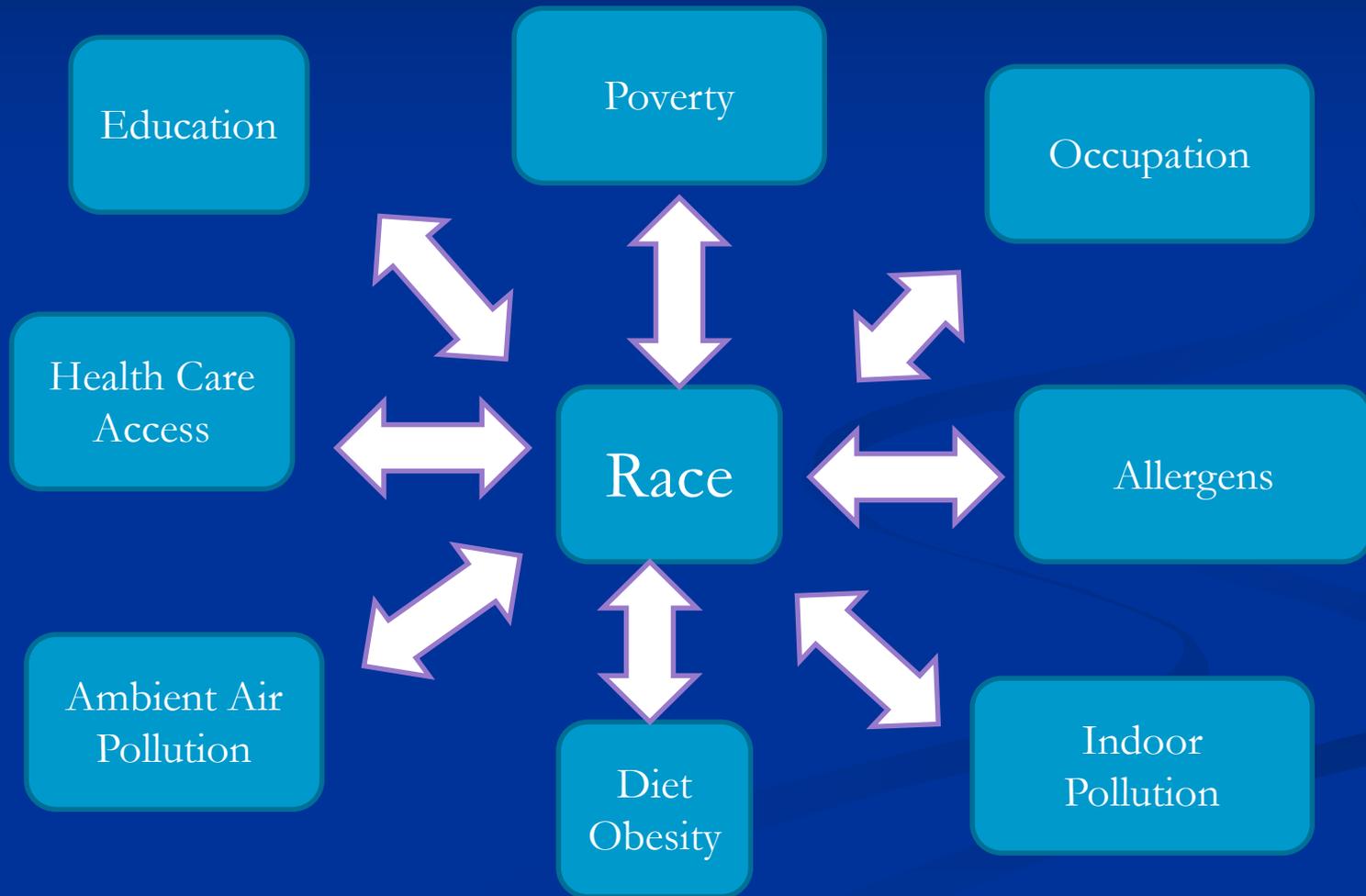
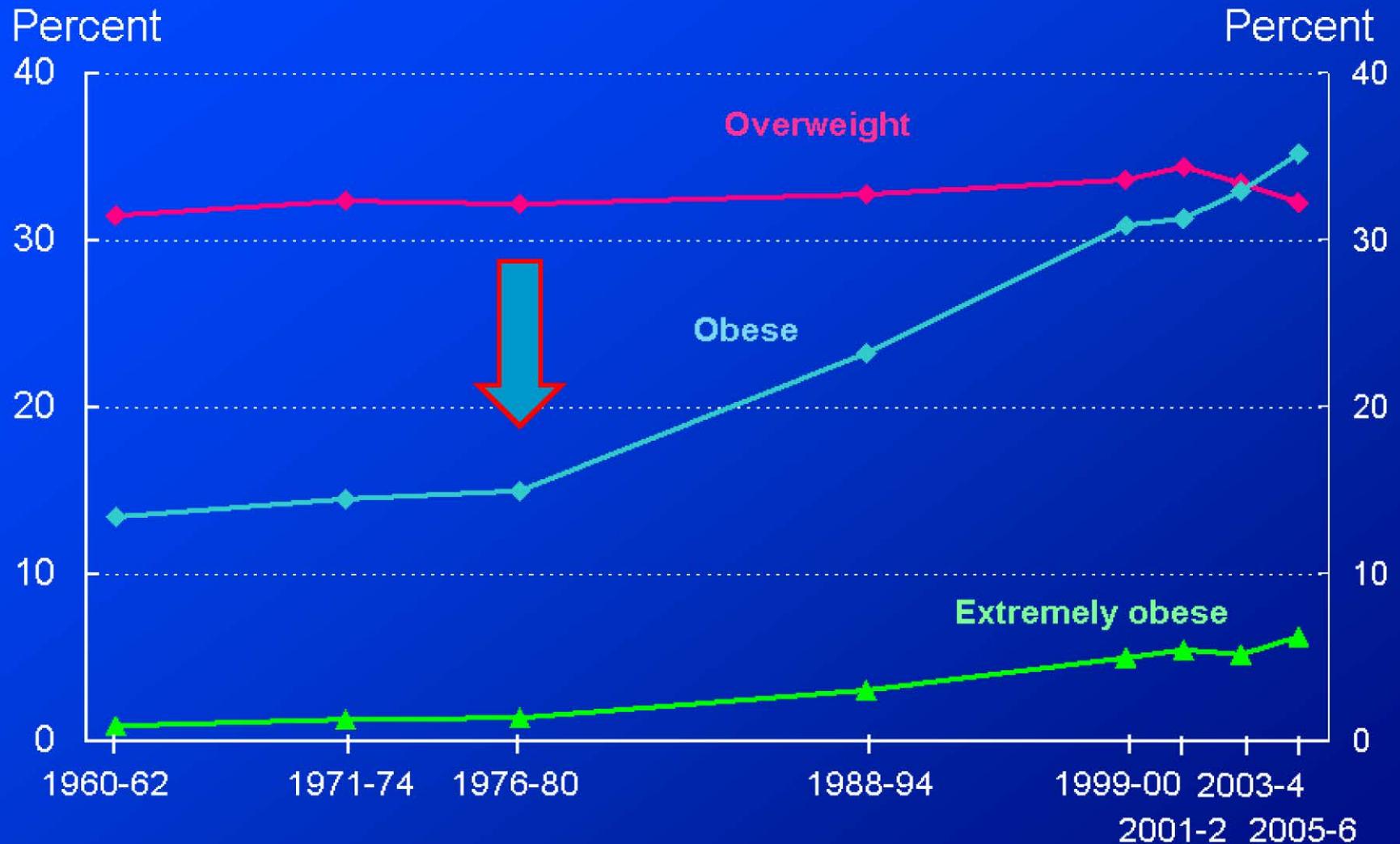


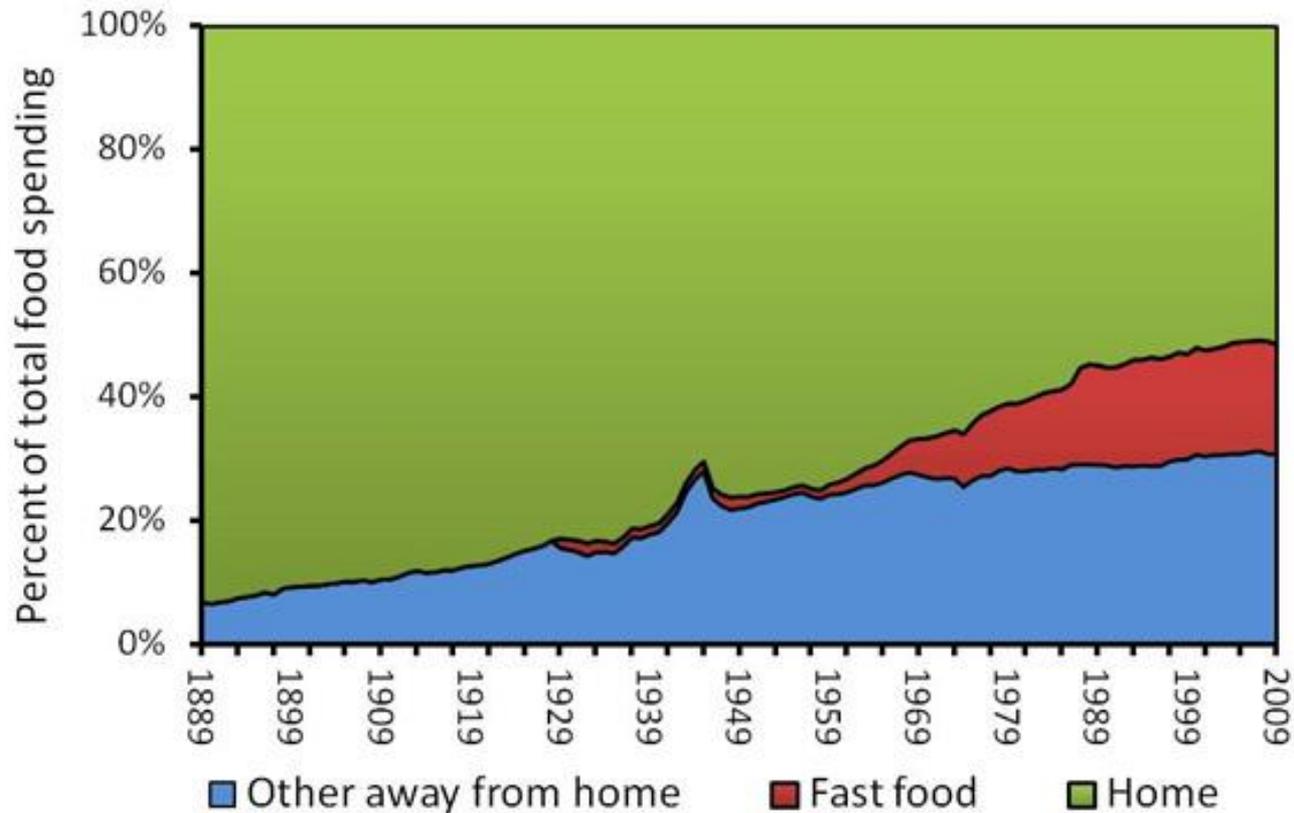
Figure 2. Trends in overweight, obesity and extreme obesity, ages 20-74 years



Note: Age-adjusted by the direct method to the year 2000 US Bureau of the Census using age groups 20-39, 40-59 and 60-74 years. Pregnant females excluded. Overweight defined as $25 \leq \text{BMI} < 30$; obesity defines as $\text{BMI} \geq 30$; Extreme obesity defines as $\text{BMI} \geq 40$.

Dietary Change in the U.S.

The Rise of Commercially Prepared Food



USDA Economic Research Service

Change in U.S. Diet



↑ INTAKE

- Processed foods (refined grains, meats, “fast foods”)
- High fat foods, n6-PUFAs
- Sugar-enriched desserts and drinks

↓ or stable INTAKE

- Whole grains, poultry, fruits and vegetables
- Low fat foods, n-3 PUFAs, antioxidants

Observational evidence that Diet impacts Asthma

- Nutrients (e.g., vitamins C, D E, ω -3 fatty acids)

(Allan et al., *Am Diet Assoc* 2009)

- Foods (e.g., fruit, vegetables, and fish)

(Nurmatov et al., *J Allergy Clin Immunol* 2011)

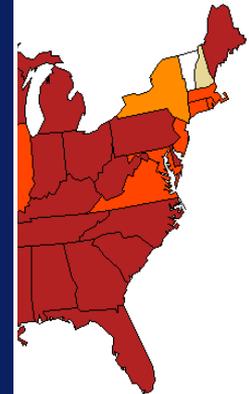
- Dietary patterns (e.g., Mediterranean diet)

(Lv et al., *J Asthma Allergy* 2014)

- Western Diet pattern (e.g. high processed meat)

(Brigham al., *Annals Allergy Asthma Immunol* 2015)

State-specific Prevalence of Obesity* Among U.S. Adults, by Race/Ethnicity,



(*BMI ≥ 30)

 No sufficient sample**

 25–29

 < 20

 30–34

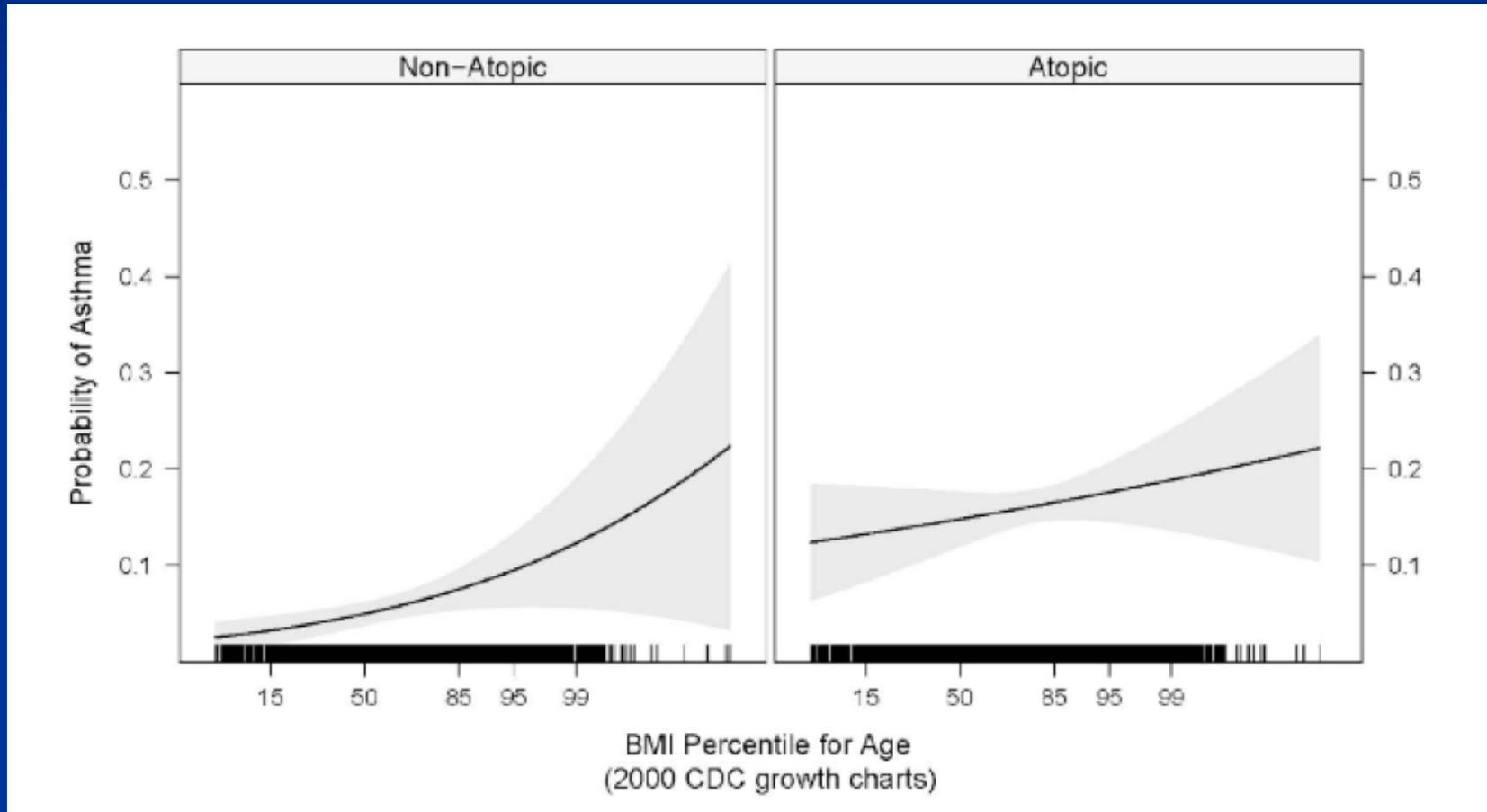
 20–24

 35+



Source: CDC Behavioral Risk Factor Surveillance System.

BMI and asthma prevalence in children and young adults NHANES



Obesity enhanced respiratory health effects of ambient air pollution in Chinese children: the Seven Northeastern Cities study

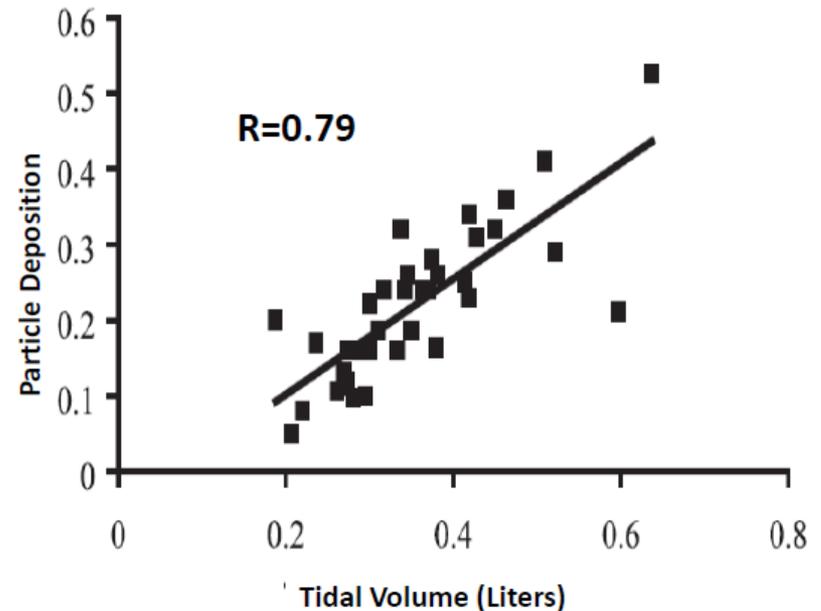
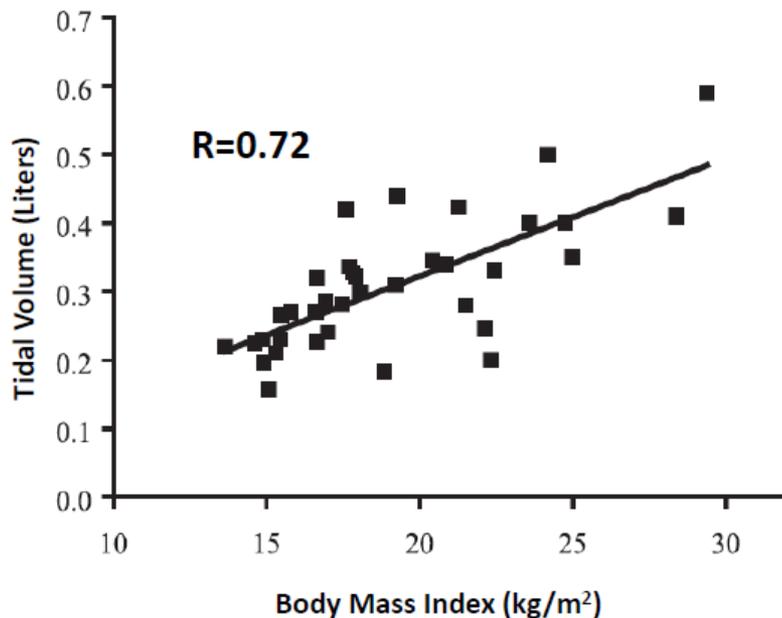
GH Dong^{1,2,3}, Z Qian³, M-M Liu¹, D Wang¹, W-H Ren⁴, Q Fu⁵, J Wang⁵, M Simckes³, TF Ferguson⁶ and E Trevathan³

- >30,000 children ages 2 to 14 years
- Overweight and obese compared to normal weight:
 - Increased symptoms in response to NO₂ and PM₁₀
 - Increased risk of doctor diagnosed asthma in response to SO₂ and PM₁₀

Effect of body size on breathing pattern and fine particle deposition in children

Tidal Volumes Increase with Increasing BMI*

Particle Deposition Increases with Increasing Tidal Volume*



Particle deposition was 2.8 times greater in overweight compared to leanest children.

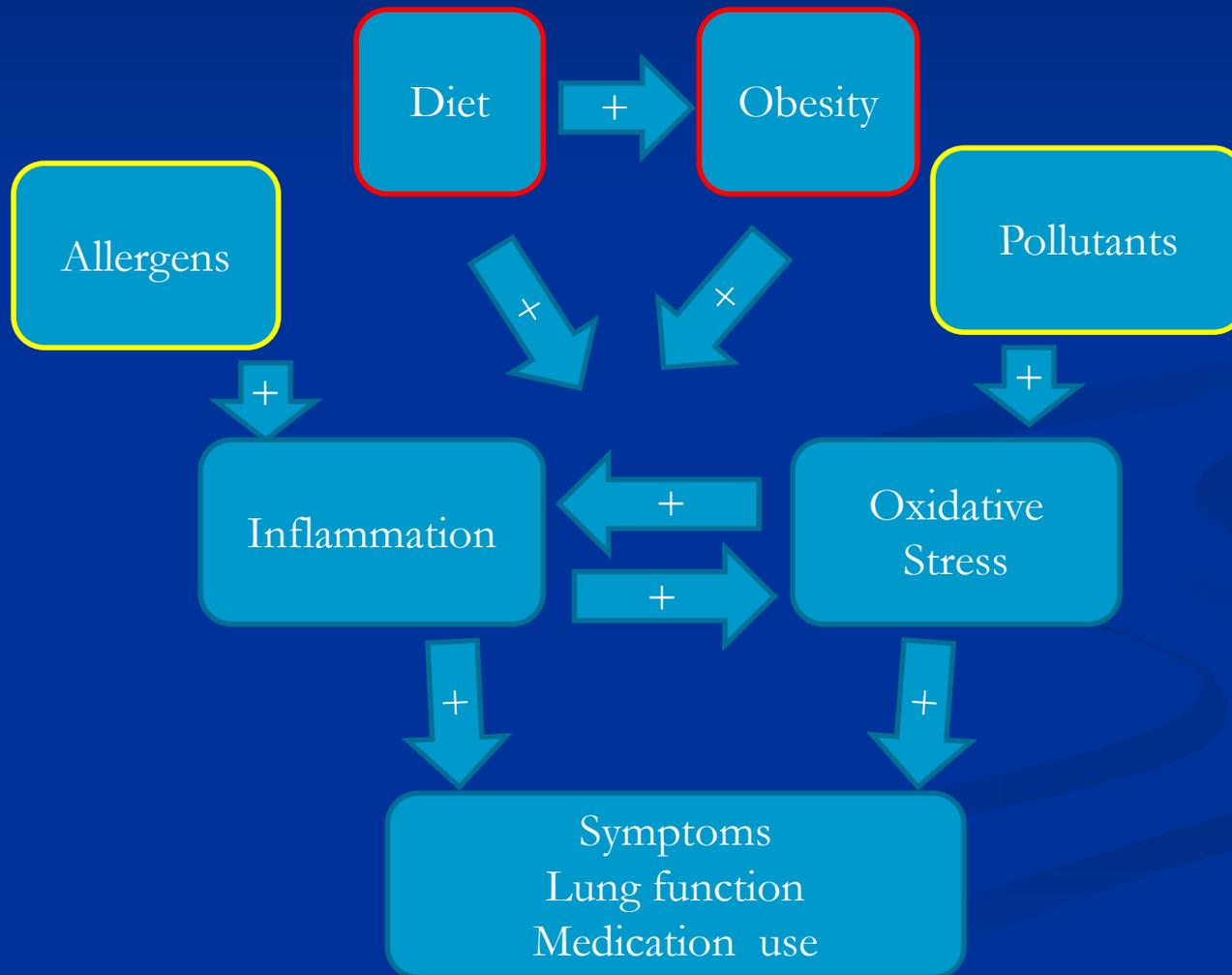
*Relationships were significant after adjusting for height, and age.

Potential Mediators of Susceptibility

- Differences in particle deposition due to differences in breathing patterns⁵
- Enhanced oxidative stress and inflammatory response to pollutant exposure¹⁻⁴
- Enhanced hyperresponsiveness related to adipokines
- Corticosteroid resistance with increased weight⁶
- Differential prevalence in comorbidities⁷

1. Dubowsky SD et al. EHP 2006; 2. Johnston RA et al. J App Phys 2008; 3. Holguin et al. 2010; 4. Keaney JF 2003; 5. Bennett WE 2004; 6. Sutherland AJRCCM 2008; 7. Chen JC EHP 2007

Diet and Obesity Modify the Response to Inhaled Allergens and Pollutants



Major Dietary Sources of Energy

	5-8 yrs	% of Energy	9-13 yrs	% of Energy
	Milk	13.9	Chips	10.1
	Pizza	7.9	Pizza	9.1
	Chips	7.7	Rice & Pasta	7.4
	Sweetened Drinks	7.5	Chicken	6.0
	Cereals	7.1	Cereals	5.7
	Breads	5.5	Milk	5.6
	Sandwich/Burger	5.2	Meat	5.3
	Chicken	5.1	Soda	4.8
	Sweetened juices	3.9	Sweetened Drinks	4.8
	Meat	<u>3.6</u>	Sandwich/Burger	<u>4.7</u>
Total		67.3		63.4

Intake of Energy & Selected Nutrients: Boys 5-8 yrs

	Median	DRI
Energy (kcal)	2097	1600
Dietary Fiber(g)	13.1	25
Saturated Fat (g)	29.6	As low as possible
Monounsaturated Fat (g)	15.1	
Polyunsaturated Fat (g)	8.5	
Omega 3 FA(g)	0.5	1.2
Omega 6 FA (g)	7.4	1.2
Potassium (mg)	1974	3800
Sodium (mg)	3144	1200
Adequate: Folate, B-12, Iron, Calcium, Vitamin C and D		

DRI: Dietary Reference Intake, using Adequate Intake and Recommended Daily Allowance

Dietary Interventions in Asthma

JAMA[®]

Online article and related content
current as of December 17, 2009.

**Effects of Protein, Monounsaturated Fat, and
Carbohydrate Intake on Blood Pressure and Serum
Lipids: Results of the OmniHeart Randomized Trial**

Lawrence J. Appel; Frank M. Sacks; Vincent J. Carey; et al.

JAMA. 2005;294(19):2455-2464 (doi:10.1001/jama.294.19.2455)

Follow the DASH diet to potentially
lower your blood pressure.

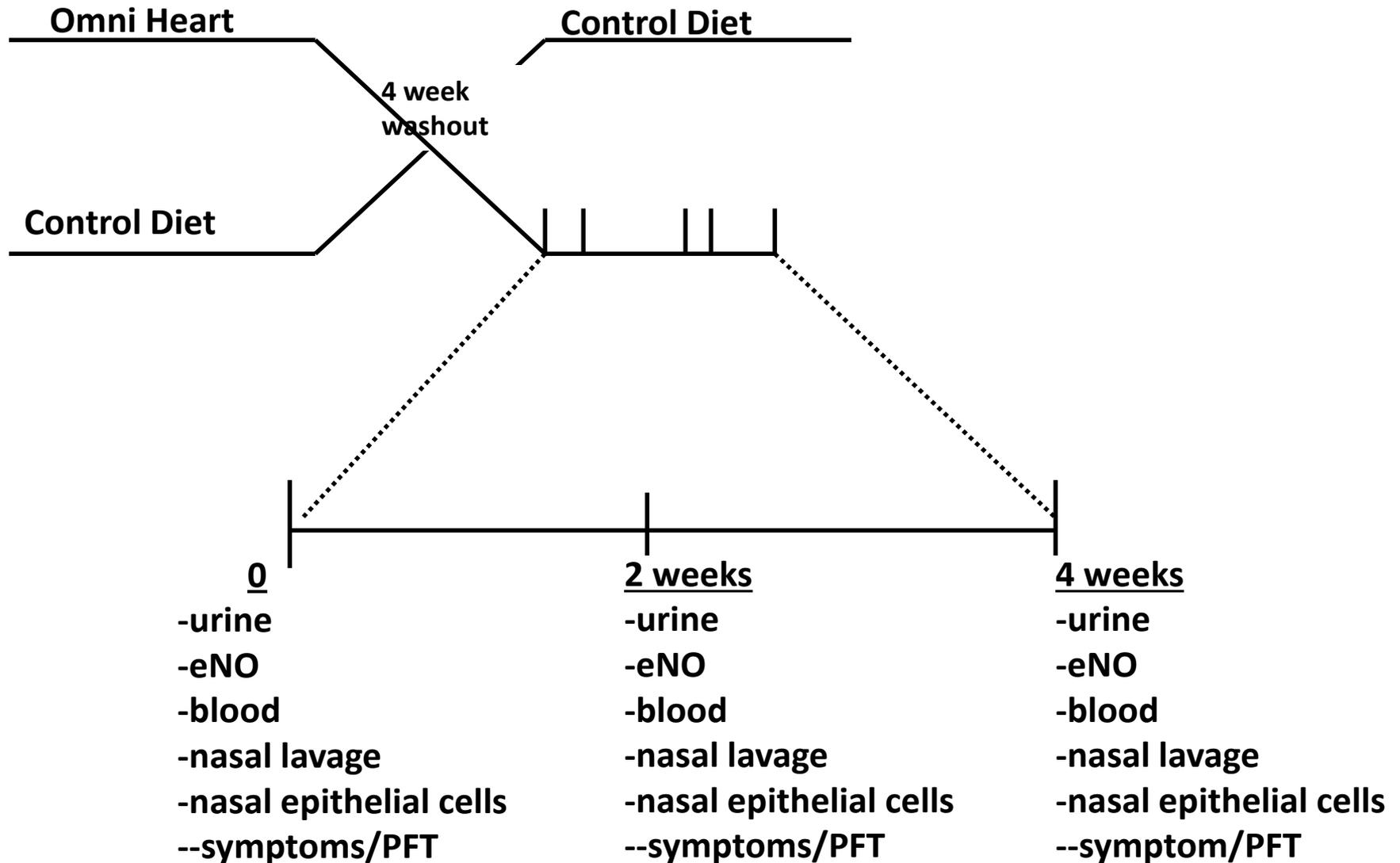


Mediterranean type diet,
Derived from DASH

Higher unsaturated fat
From

Olive oil
Canola oil
Safflower oil
Nuts and seeds

Study Design



Sample menu from OmniHeart

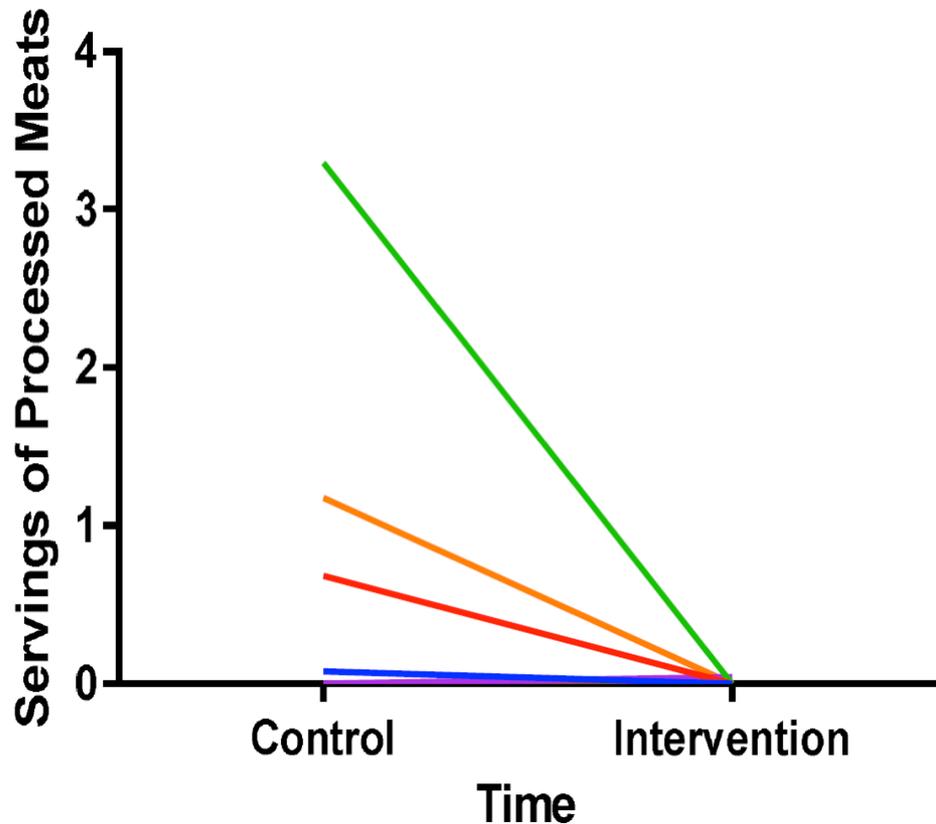
Breakfast	Orange juice Cereal with raisins, skim milk White bread toast with olive oil margarine and jelly
Lunch	Chicken sandwich: white bread, chicken breast, barbeque sauce, olive oil margarine Olive oil potato chips Spinach salad with tomato and olive oil balsamic dressing Broccoli salad with safflower oil Tomato juice
Dinner	Black bean taco: black beans with vegetables, 3-grain pilaf with olive oil* Tortilla chips Carrots, cooked Pecan cookie Skim milk
Snack	Mandarin oranges Almonds

Research Kitchen

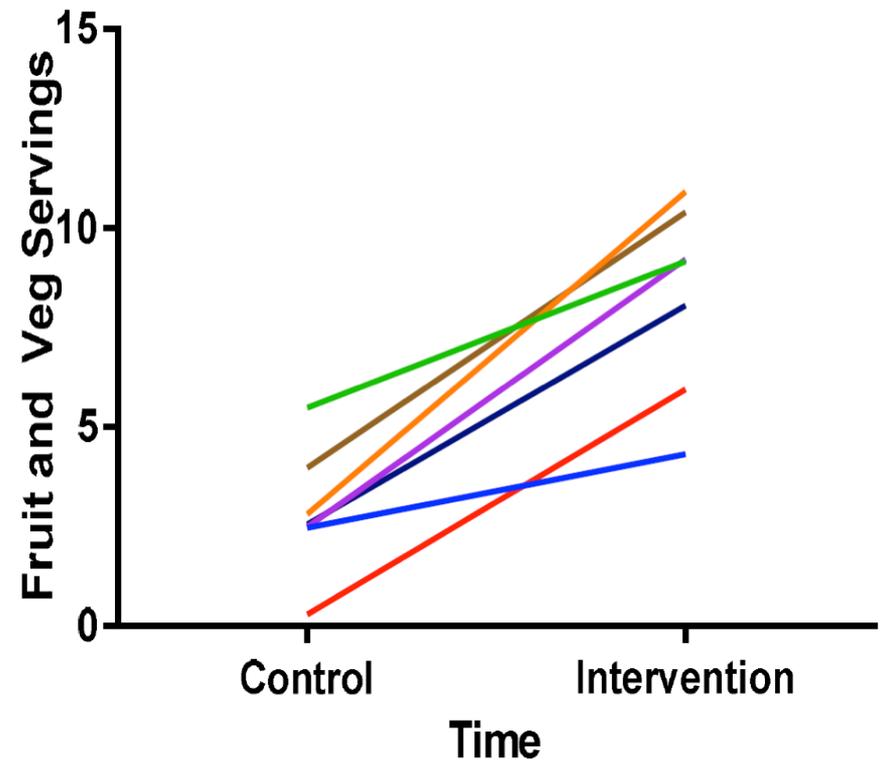


Changes in report of dietary intake

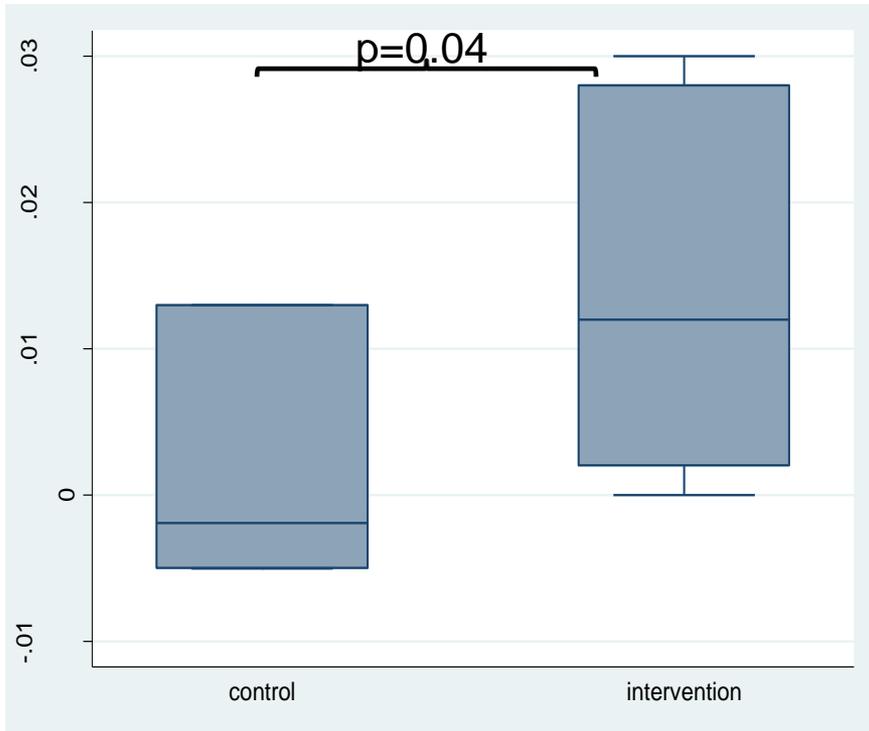
Processed Meats



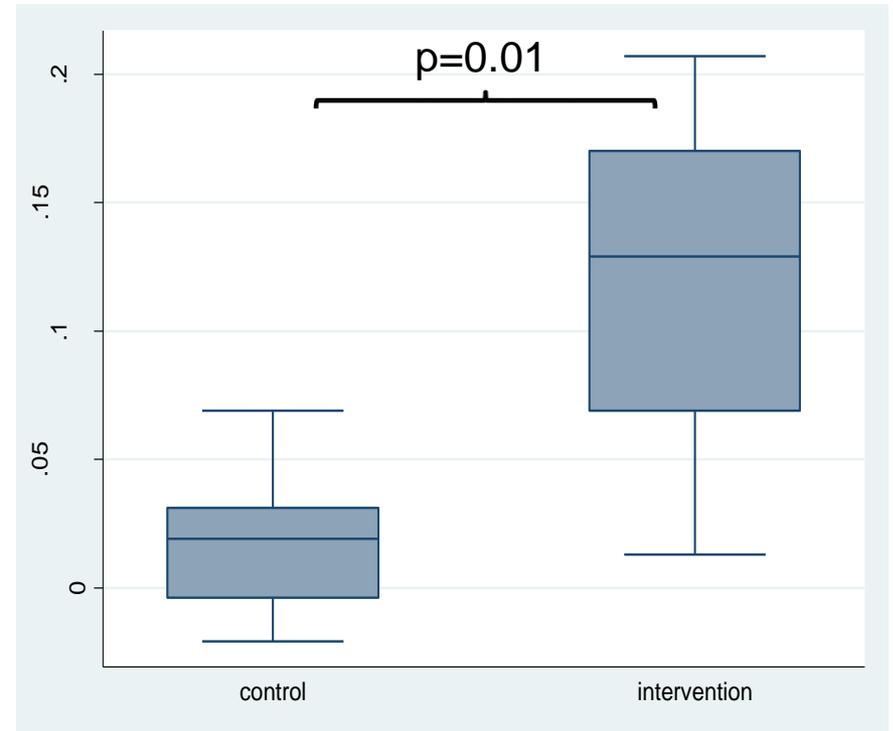
Fruit and Veg Intake



Changes in Serum Caretenoids

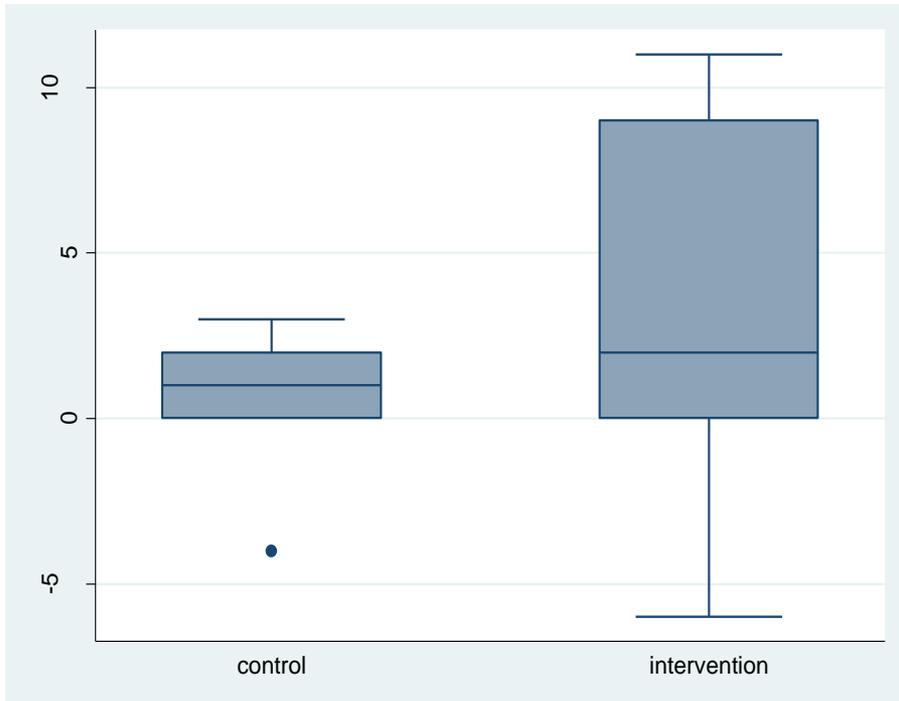


Change in Alpha Carotene

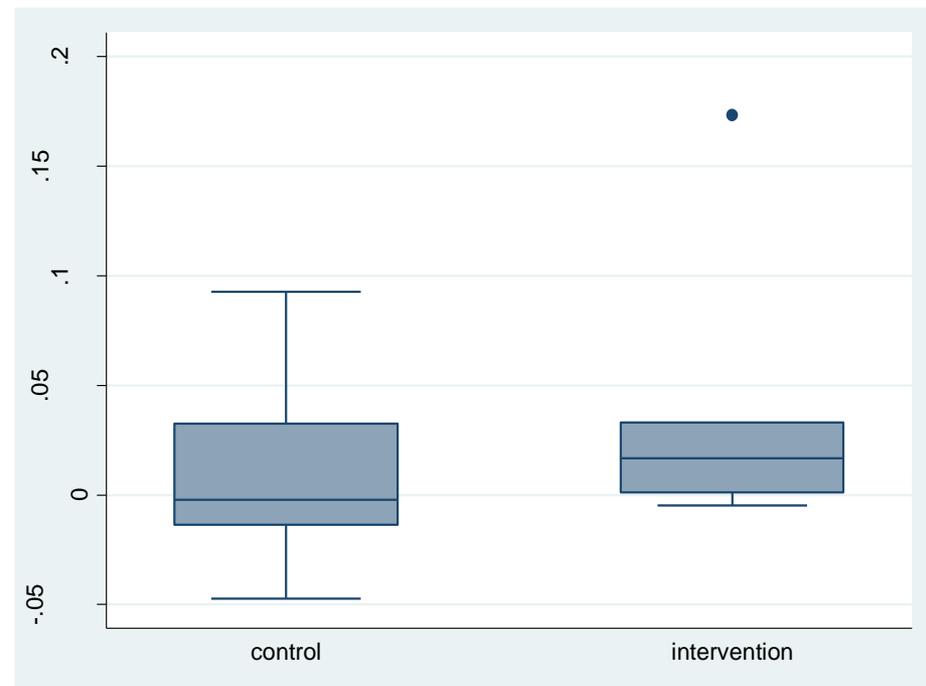


Change in Lutein

Changes in Asthma Outcomes

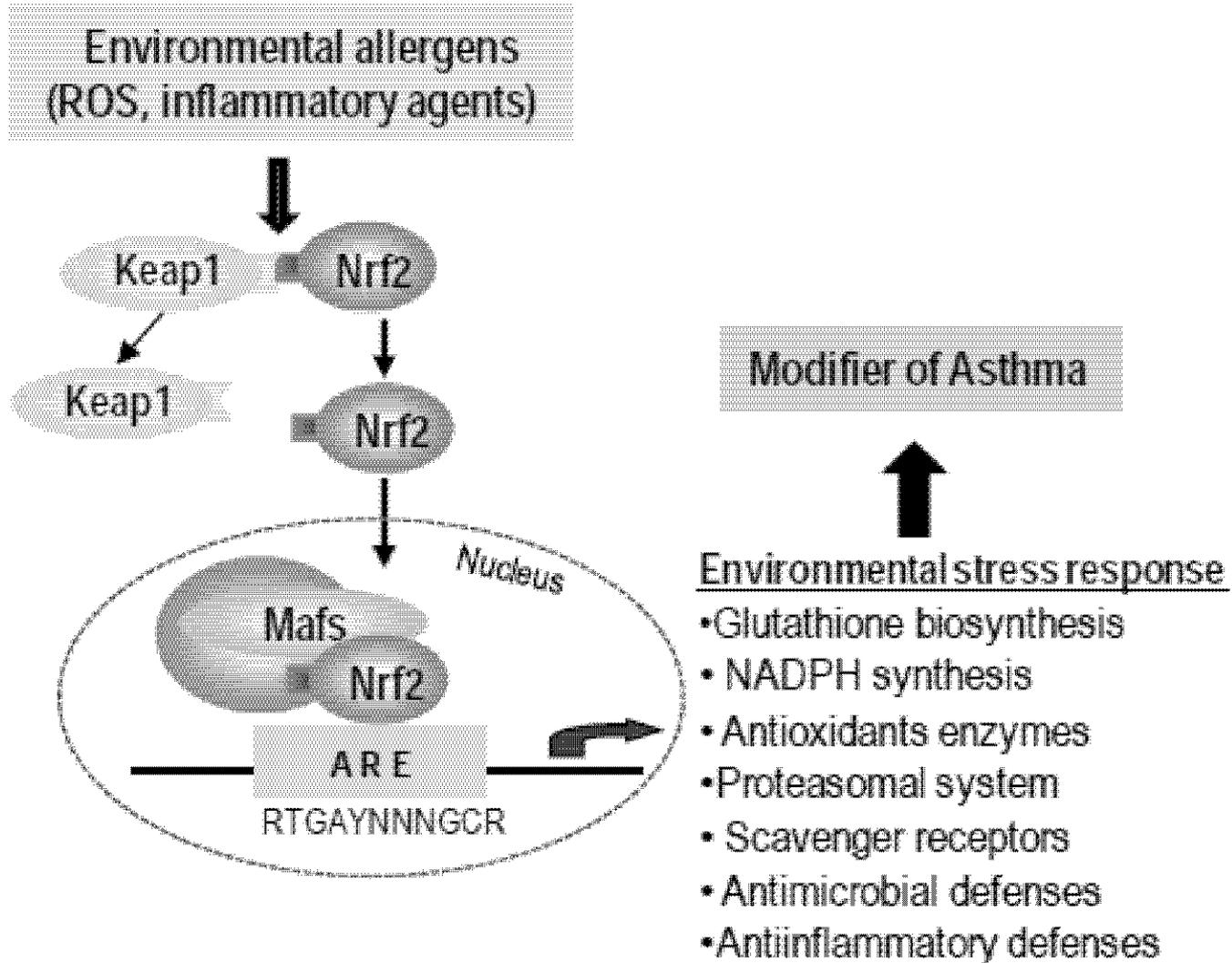


Change in Asthma Control Test Scores



Changes in Lung Function

Nrf2- Keap1 System



...our major cellular defense against oxidative stress



Cruciferous vegetables



- **Broccoli sprouts***
Brassica oleracea
- Cabbage
- Cauliflower
- Bok choy
- Kale
- Collard greens
- Chinese broccoli
- Kohlrabi
- Mustard
- Turnip
- Radish
- Arugula
- Watercress
- Broccoli raab

Cruciferous vegetables belong to the family of plants “Cruciferae” and genus “Brassicaceae”

Activators of Nrf2



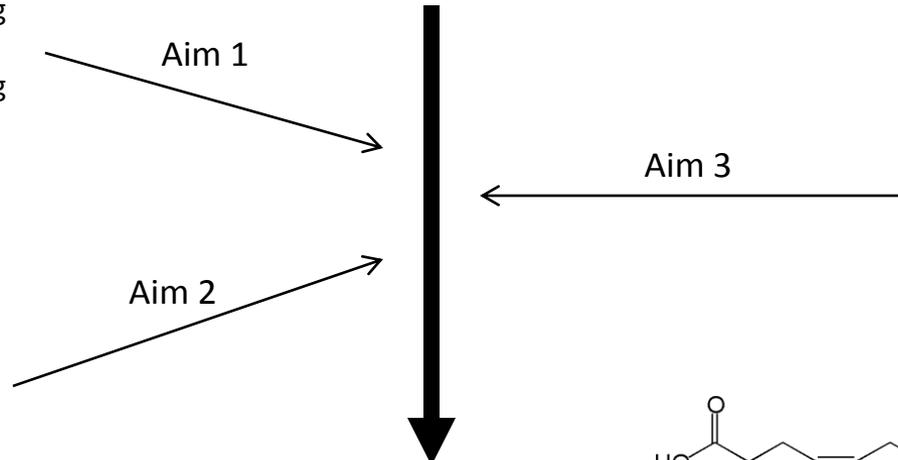
- SA1.1: Oral activation of Nrf2
- SA1.2: Specific effects during challenge
- SA1.3: Specific effects during sensitization



Genetic activation of Nrf2, via Keap1 deletion in airway epithelium, dendritic cells and CD4 T cells

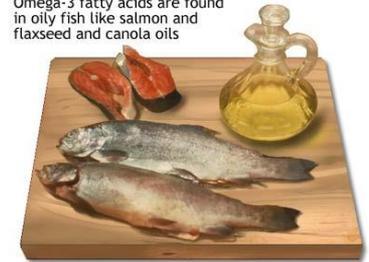


Ova, house dust mite, or PM sensitization and challenge



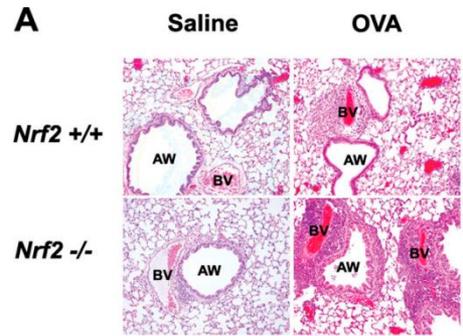
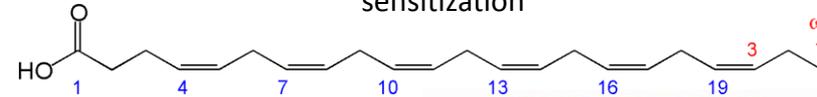
Omega-3 Fatty Acids Docosahexaenoic acid (DHA)

Omega-3 fatty acids are found in oily fish like salmon and flaxseed and canola oils



ADAM

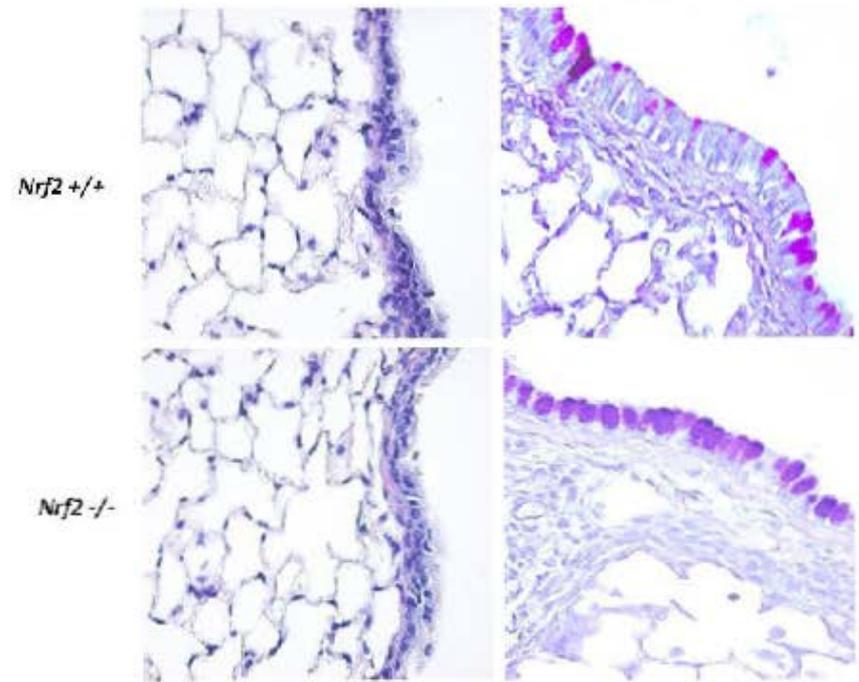
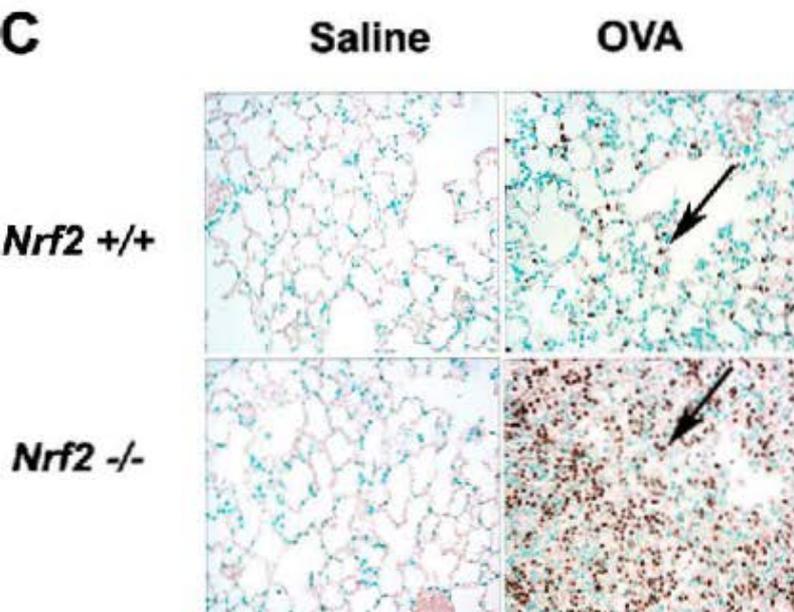
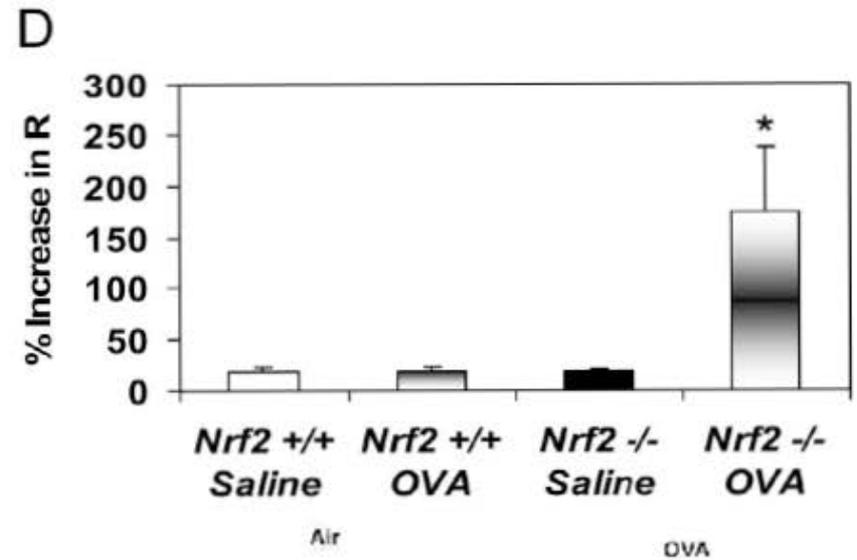
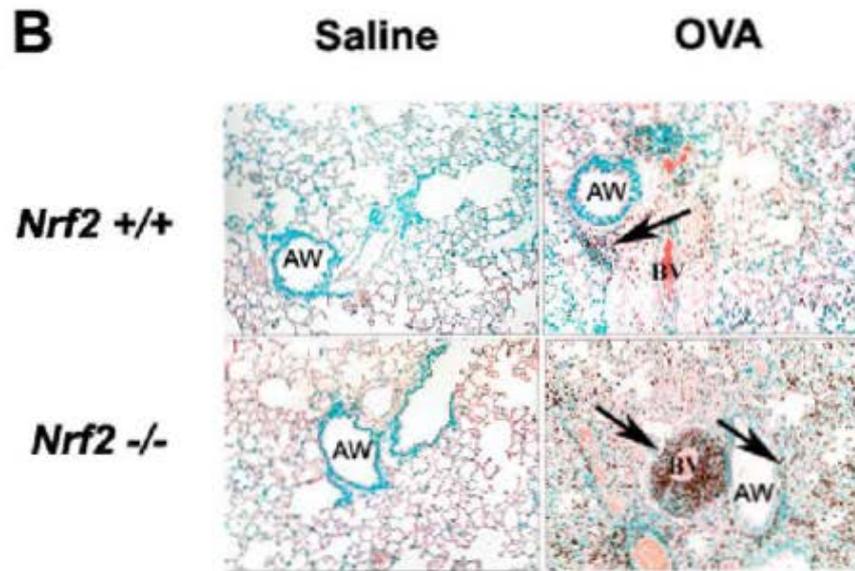
- SA3.1: DHA
- SA3.2: Specific effects during challenge
- SA3.3: Specific effects during sensitization



Inflammation
Cytokines
AHR
Mucus

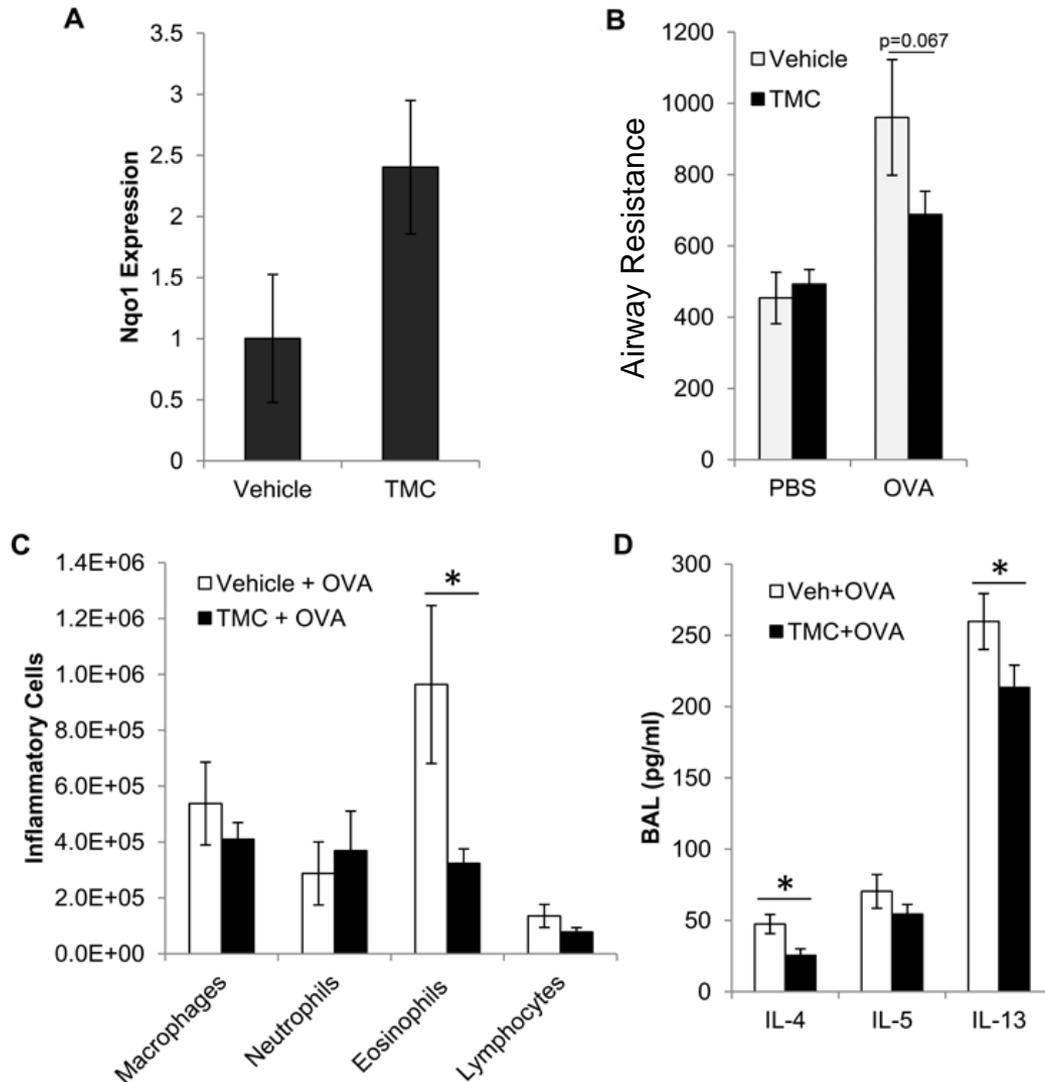


Nrf2-deficiency increases allergic asthma

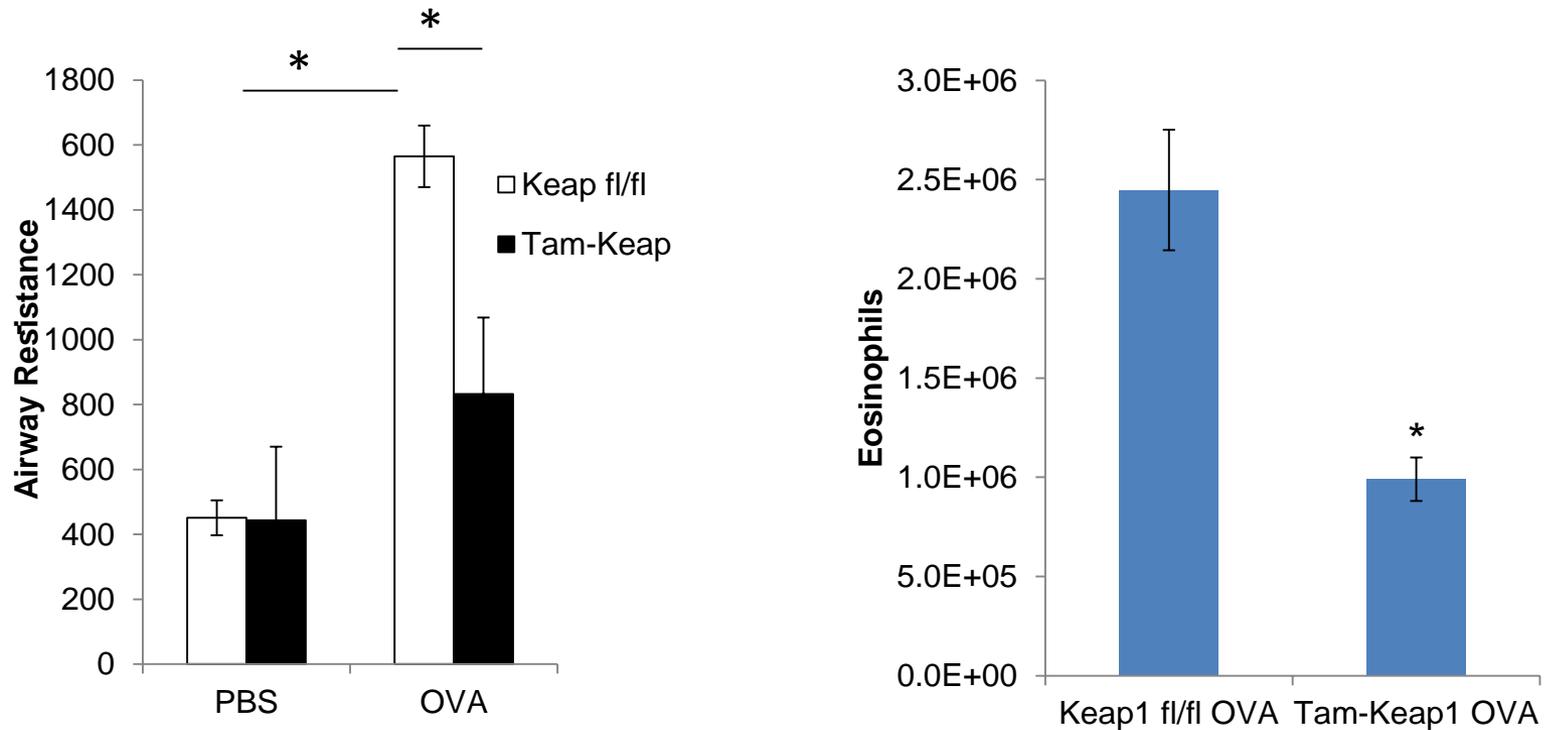


Feeding Nrf2 activator, TMC, reduces asthma

Sussan TE, et al *Am J Physiol Lung Cell Mol Physiol*. 2015 Jul 1; 309(1): L27-36



Genetic activation of Nrf2 reduces asthma



Sussan TE, et al Am J Physiol Lung Cell Mol Physiol. 2015 Jul 1; 309(1): L27-36

Buffalo Chicken Wrap



Tuna salad



What's for lunch?

Seafood Salad Wrap

Salad made of sweet crab meat, real shrimp, celery, onion, and mayonnaise
- all wrapped up in a sandwich wrap.

Tuna Salad Wrap

Creamy tuna salad made with onion, celery, pickle relish and mayonnaise.
Just like mom used to make!

Buffalo Ranch Chicken Wrap

Spicy buffalo ranch sauce with bacon over crispy chicken with lettuce, celery, and tomatoes.
Served with extra hot sauce on the side.

Barbeque Chicken Wrap

Crispy chicken smothered in sweet and tangy barbeque sauce with lettuce.
Extra barbeque sauce on the side.

Beef Tacos

4 crunchy taco shells served with taco beef and nacho cheese, with diced tomato garnish.
Sour cream and taco sauce served on the side.

Please choose one lunch item for each day of the week.
Your choices will be repeated for the second week.



Sulforaphane and Induction of Phase II Enzymes in Respiratory System

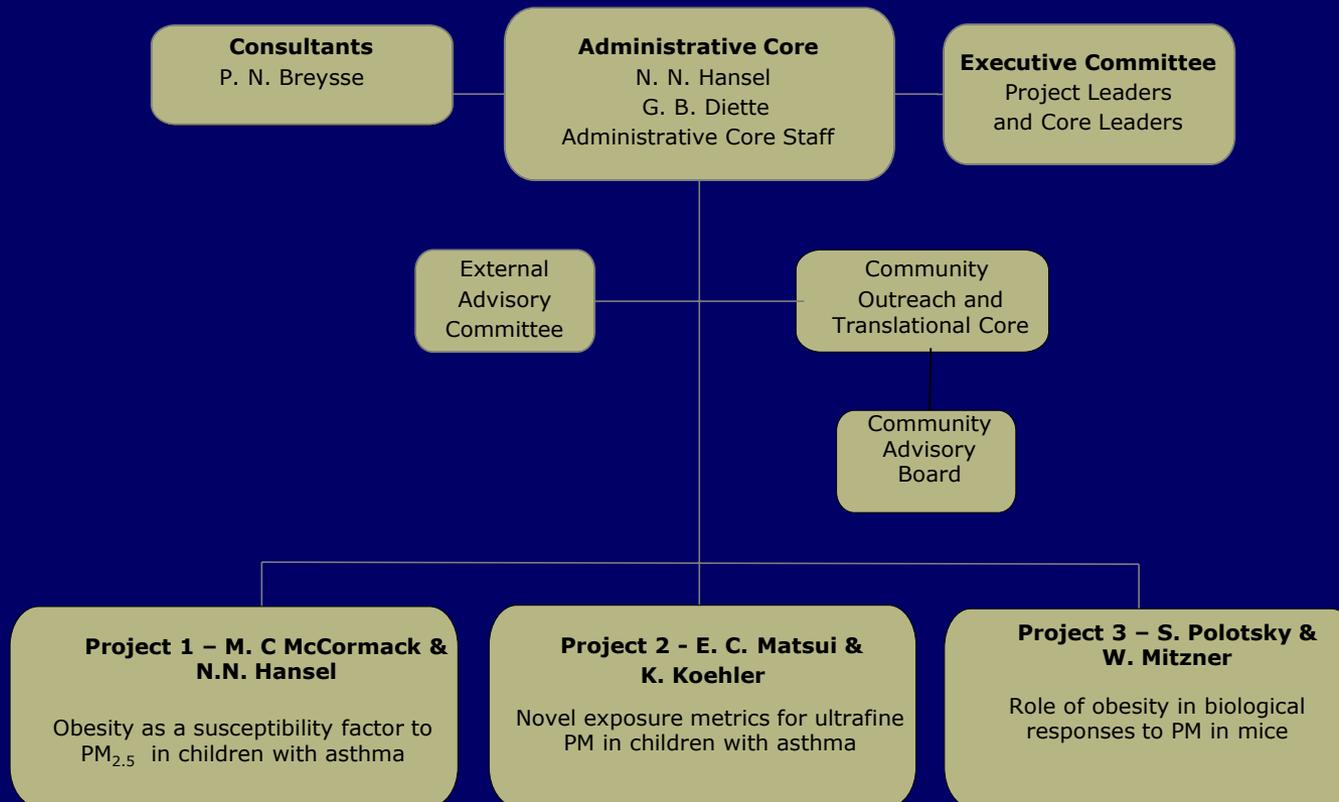
BS Dose (homogenate form)	H0-1 (mean % change)	NQO1 (mean % change)
25g	4.43	-2.17
100g	15.32	13.86
125g	37.8	53.32
150g	105.1	142.19
175g	106.6	160.19
200g	120.9	198.8

Daily ingestion of BSH prepared from fresh BS 3 days

Gene expression from nasal lavage performed 2 hours after last BSH dose

P50: Children's environmental health and disease prevention research center

OBesity Enhances Susceptibility to Pollutant Effects in Asthma (OBESE ASTHMA)



Obesity as a susceptibility factor to pollution exposure in asthma - Organizational Chart

Acknowledgements

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