



Biochemical Consequences of Stress



What is Stress?

Any Change to Your Physiology

- Acute infection
- Chronic disease
- Cellular inflammation
- Sleep deprivation
- Exercise
- Environmental change
- Low blood sugar
- Emotions



Excess Cortisol is Secreted in Response to Chronic Stress



Cortisol is Really An Anti-Stress Hormone

Reduces production of pro-inflammatory eicosanoids

But if the body is making too many pro-inflammatory eicosanoids, cortisol levels will increase

Increases in cortisol can be organ specific



Hormonal Effects of Excess Cortisol

Makes You Fatter

- Increased Insulin Resistance

Makes You Sicker

- Inhibition of the Immune System

Makes You Dumber

- Neural Cell Death

Makes You Age Faster

- All of the above mechanisms



Conditions Associated with Excess Cortisol

Insulin resistance

Fat accumulation

Thinning skin

Cognitive loss

Obesity

Heart disease

Cancer



Cortisol-Obesity Connection

Blood levels can be normal

Adipose levels can be highly elevated

- Body's attempt to reduce adipose tissue inflammation

Body fat is correlated lack of ability to handle stress

- McInnis et al. Brain Behavior Immun 42: 33 (2014)



Stress and Inflammation

Increased sympathetic activation activates NF- κ B

NF- κ B increases gene expression of inflammatory cytokines

- IL-6
- Increase in CRP

Increased stress and chronic disease

- Cohen et al. PNAS 106: 5995(2012)



Psychological Risk Factors Associated with Increased Inflammation in Healthy, Young Adults

Depression ($p < 0.01$)

Anger ($p < 0.05$)

Hostility ($p < 0.01$)

Suarez Psychosomatic Med 66:684 (2004)



Effects of Sleep Deprivation

Increased cortisol secretion

Increased insulin resistance

Increased weight gain

Decreased cognition



Can Anti-Inflammatory Nutrition Overcome Effects of Sleep Deprivation?

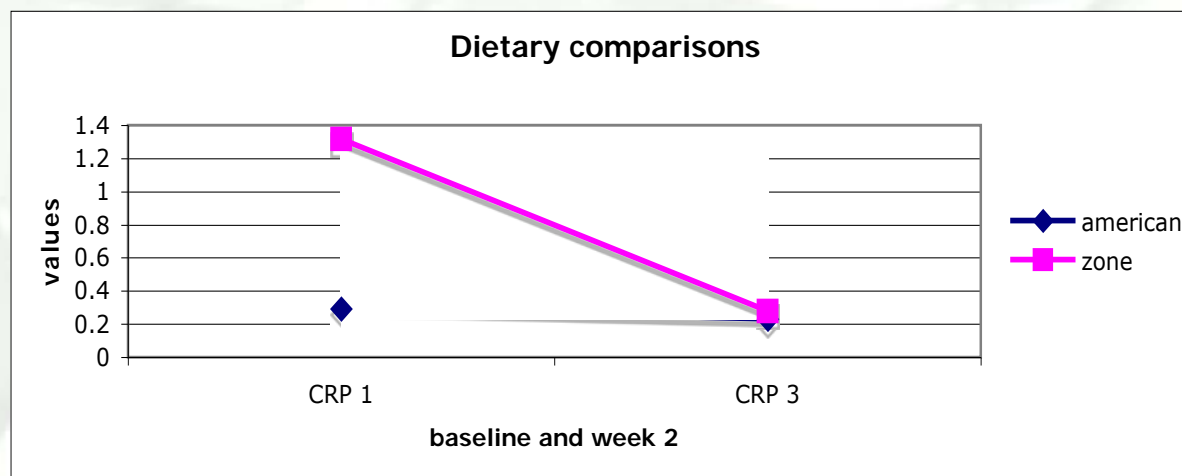
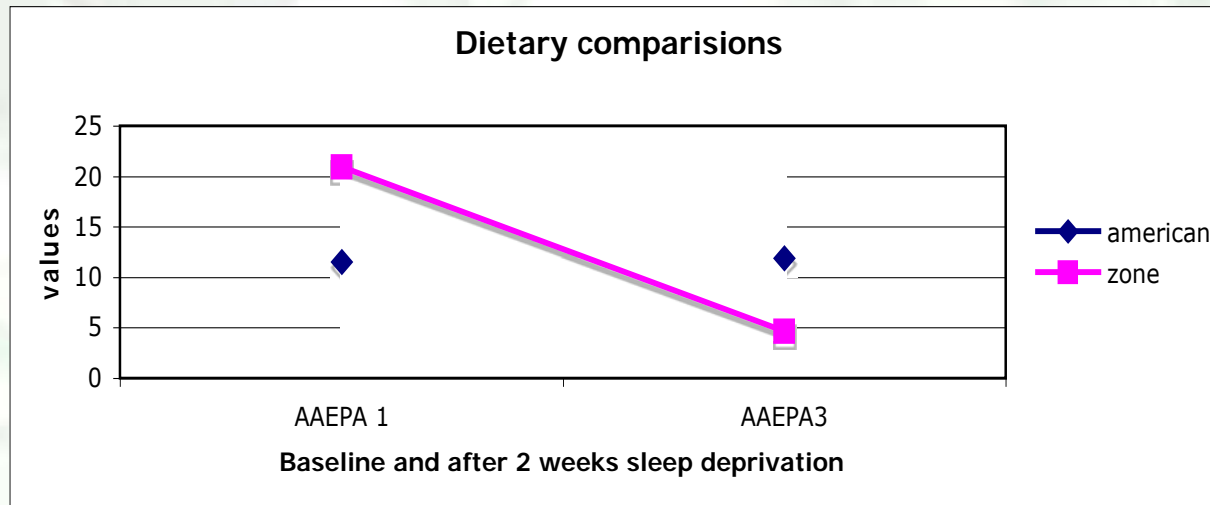


Subjects (n=16)

	Group A	Group Z
Average Age	27.8	26.8
Average Weight (kg)	71.8	74.55
% Male	60	60
% Female	40	40
Average BMI at start	24.25	24.36
Average % Body Fat at start	19.01	20.48
% Caucasian	50	33
% Hispanic	20	33
% Asian	10	11
% Other (Indian, Black)	20	22
Average # consec hrs sleep	4.68	4.78
Average activity level	6.12	4.42
Average AA/ EPA start	10.8	18.29
Average RMR at start	1637	1800

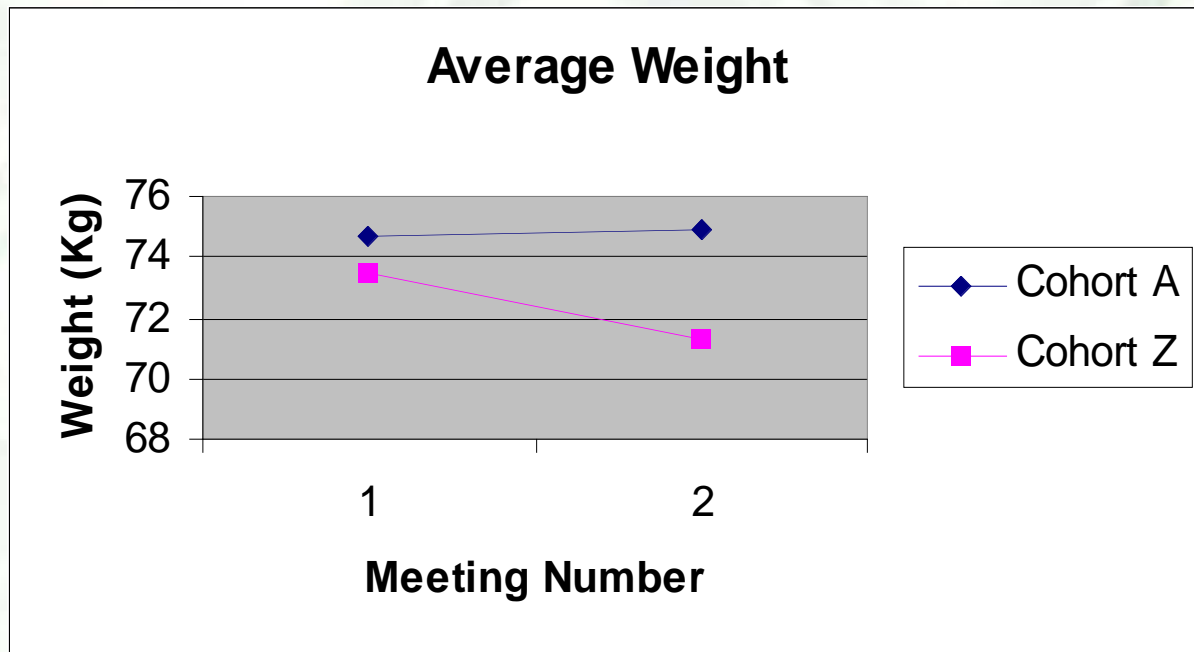


Inflammation



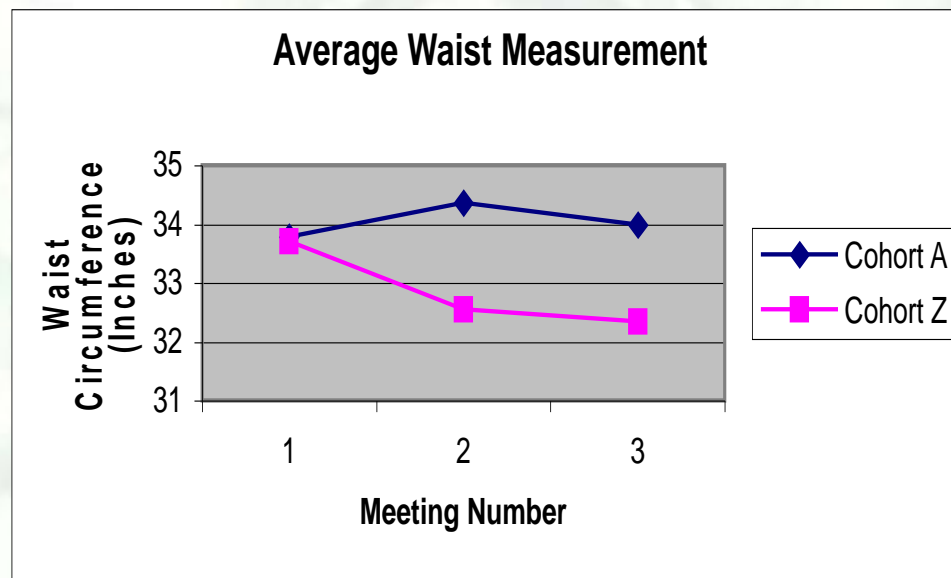


Weight



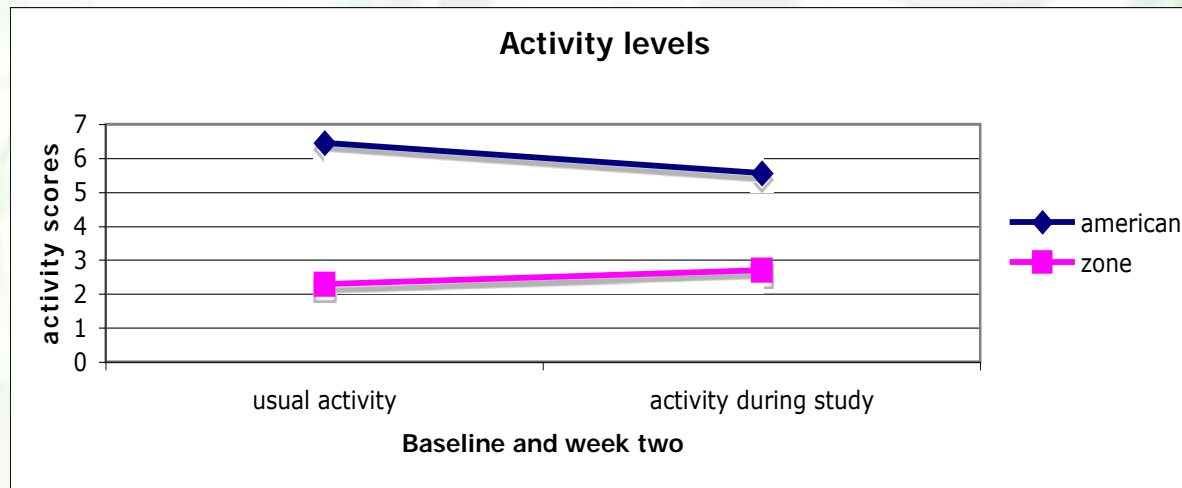


Waist Circumference



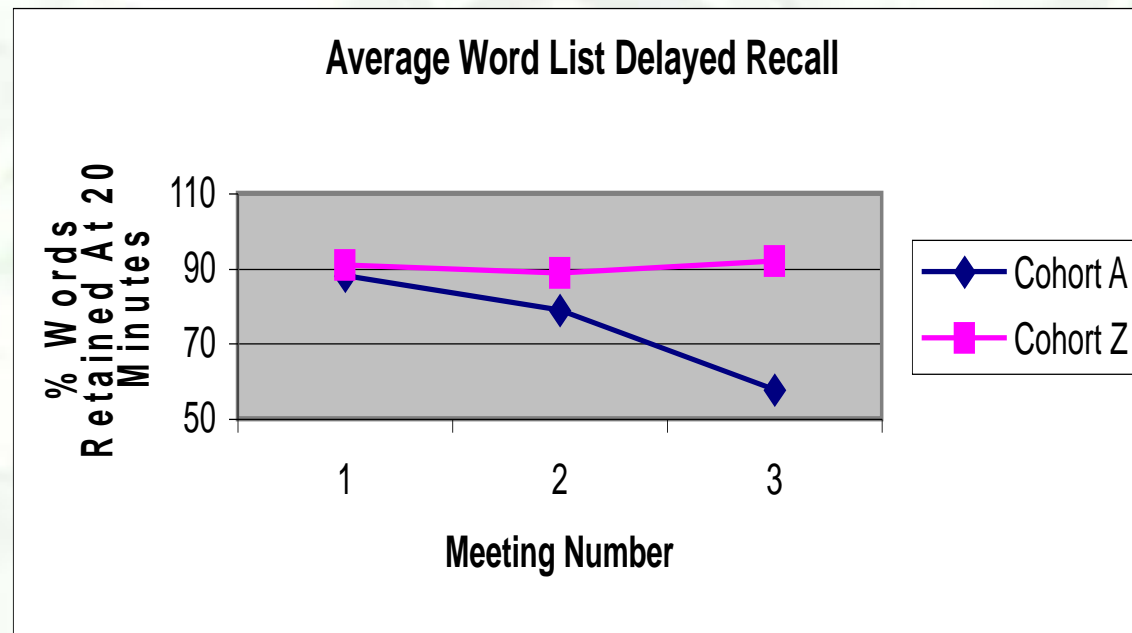


Physical Activity





Cognitive Functioning





Results Summary

Weight decreased ($p < 0.001$)

Waist circumference decreased ($p=0.006$)

Total cholesterol decreased ($p=0.03$)

TG/HDL ratio decreased ($P=0.04$)

AA/EPA ratio decreased ($p < 0.001$)

Cognition (Verbal Word Retention)
increased ($p=0.03$)



Effect of the Zone Diet on Profile of Mood States (POMS)

Vigor	+9%	$p < 0.0001$
Anger	- 8%	$p < 0.001$
Anxiety	- 6%	$p < 0.01$
Fatigue	- 6%	$p < 0.04$
Depression	- 6%	$p < 0.01$
Confusion	- 4%	$p < 0.04$

Fontani et al Eur J Clin Invest 35: 691 (2005)



Brain Wave Patterns

Gamma (>35 Hz)

- Unconscious behavior

Beta (13-35 Hz)

- Focused activity

Alpha (8-13 Hz)

- State of calmness

Theta (5-8 Hz)

- Creative activity



Effect of the Zone Diet on Brain Wave Patterns

Beta	- 33%	$p < 0.0001$
Alpha	+18%	$p < 0.01$
Theta	+11%	$p < 0.01$

Fontani et al Eur J Clin Invest 35: 691 (2005)



Conscious and Unconscious Mind

Conscious mind

- Make decisions on facts
- Awareness on task at hand
- Relatively slow (40 stimuli/second)
- Manual control

Unconscious mind

- Ingrained behavior (habits)
- Extremely fast (20 M stimuli/second)
- Allows multi-tasking
- Auto-pilot



Awareness Controls Which Mind Has the Upper Hand

Conscious mind can observe behavior

- Can stop existing behavior and create new one
- Free will

Conscious mind operates in both past and future

Subconscious mind operates only in present

Subconscious mind takes over when conscious mind is not paying attention



Mind-Body-Diet Connection

How diet can affect inflammation

How diet can affect cytokines

How diet can affect epigenetics



High-dose Fish Oil

Reduces pro-inflammatory eicosanoids

- Lowers need for cortisol

Reduces TNF and IL-6

Increases telomeres



Stable Blood Sugar Levels Lowers Need for Cortisol

Stabilization of blood sugar for the brain

Decreased need to convert muscle protein
into glucose (neoglucogenesis)

- Requires cortisol

Ketogenic diets increase cortisol and
decrease thyroid

- Ebbeling et al. JAMA 307: 2627 (2012)



Cortisol Reduction “Drugs”

Zone Diet

High-dose EPA and DHA

Moderate exercise

Meditation



Science of Meditation

Develop awareness

Reduce stress

Increases telomere length

Epigenetic changes

- Kaliman et al Psychoneuroendocrinology 40:96 (2015)



Making Meditation More Effective

Controlling hormones by the diet

- Blood
- Gut
- Brain

How?

- Zone Diet
- High-dose fish oil
- Polyphenols
- Fermentable fiber

