The True Purpose Of Nutrition

Robert H. Lustig, MD, MSL

LISPEN, Plainview, NY, Oct 24, 2023
Disclosures

Paid Advisor:
Myka Bio
Journeys Metabolic
Simplex Health
Levels Health

Unpaid Advisor:
Kuwaiti Danish Dairy

Chief Medical Officer:
Kalin Health
BioLumen
Foogal
Perfact
Learning Objectives

• To explain the subcellular pathologies that drive chronic disease, and how food can make each one worse or better
• To explain how exercise does not mitigate these pathologies
• To discern the associations between ultraprocessed food and both metabolic health and mental health
• To explain the precepts of good nutrition
  • feed the gut
  • protect the liver
  • support the brain
T2DM increasing around the world


Projected annualized inflation rate 3.88%
T2DM increasing around the world

285 MILLION IN 2010

Actual annualized inflation rate 6.55%

T2DM increasing around the world


422 MILLION IN 2014

Actual

annualized inflation rate 10.30%
T2DM increasing around the world

463 MILLION IN 2019
568 MILLION IN 2030
785 MILLION IN 2050

The money is not going to hospitals, physicians, or Big Pharma.
The money is not going to hospitals, physicians, or Big Pharma. It’s going to chronic metabolic disease.
Life expectancy vs. health expenditure over time (1970-2014)

Health spending measures the consumption of health care goods and services, including personal health care (curative care, rehabilitative care, long-term care, ancillary services and medical goods) and collective services (prevention and public health services as well as health administration), but excluding spending on investments. Shown is total health expenditure (financed by public and private sources).

Data source: Health expenditure from the OECD; Life expectancy from the World Bank. Licensed under CC-BY-SA by the author Max Roser.

The interactive data visualization is available at OurWorldInData.org. There you find the raw data and more visualizations on this topic.
US Longevity Tax: 8 yr
Obesity Longevity Tax: 15 yr
Metabolic Syndrome Tax: 20 yr
Only 7% of American Adults Have Good Cardiometabolic Health

Tufts researchers find that most U.S. adults rate poorly across five components of heart and metabolic health, with clear racial disparities.
US Longevity Tax: 8 yr
Obesity Longevity Tax: 15 yr
Metabolic Syndrome Tax: 20 yr

Life expectancy, 1970 to 2021

Source: UN WPP (2022); Zijdeman et al. (2015); Riley (2005)
Note: Shown is the ‘period life expectancy’. This is the average number of years a newborn would live if age-specific mortality rates in the current year were to stay the same throughout its life.
DIVE BRIEF

Medicare insolvency still expected by 2026, unchanged by COVID-19, trustees say

Published Sept. 1, 2021

Rebecca Pifer
Senior Reporter
HEALTH PROBLEMS AND ABSENTEEISM ARE A HUGE COST TO THIS BUSINESS.

SO? So give me a raise, or I'll eat unhealthy food and avoid all forms of exercise.

YOU ALREADY DO THOSE THINGS. How could you possibly know that?
TOXIC PILLS AND SURGERY

LIFESTYLE CHANGE
Bon Appétit.

So many people (and half of Hollywood) are suddenly thinner, having swapped their old diets for a dose of the diabetes drug Ozempic.

BY MATTHEW SCHNEIER
Definitions

• **Food Science:** What happens between the ground and the mouth

• **Nutrition:** What happens between the mouth and the cell

• **Metabolic Health:** What happens inside the cell
IT’S ONLY WHAT HAPPENS INSIDE THE CELL THAT LEADS TO DISEASE

• **Food Science:** What happens between the ground and the mouth

• **Nutrition:** What happens between the mouth and the cell

• **Metabolic Health:** What happens inside the cell
Consultative Brief – March 2023

New Frontiers of Nutrition

Evolved science-based insights from global nutrition experts to inform food system transformation.
Consultative Brief – March 2023

New Frontiers of Nutrition

Evolved science-based insights from global nutrition experts to inform food system transformation.

The True Purpose Of Nutrition:
METABOLIC HEALTH
Consultative Brief – March 2023

New Frontiers of Nutrition

_Evolved science-based insights from global nutrition experts to inform food system transformation._

The True Purpose Of Nutrition:
METABOLIC HEALTH

_OK, what is that?_
The Hateful (or Grateful) Eight

The Diseases That Aren’t Diseases

Subcellular Pathologies that Belie Aging

Lustig, METABOLICAL, Spring 2021
The Hateful (or Grateful) Eight

The Diseases That Aren’t Diseases

Subcellular Pathologies that Belie Aging

• 1. Glycation (carbon deposits)
The Hateful (or Grateful) Eight

The Diseases That Aren’t Diseases

Subcellular Pathologies that Belie Aging

• 1. Glycation (carbon deposits)
• 2. Oxidative Stress (rusting)
The Hateful (or Grateful) Eight
The Diseases That Aren’t Diseases
Subcellular Pathologies that Belie Aging

• 1. Glycation (carbon deposits)
• 2. Oxidative Stress (rusting)
• 3. Mitochondrial Dysfunction (transmission)
The Hateful (or Grateful) Eight

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Lustig, METABOLICAL, Spring 2021
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• 6. Inflammation (rotted fuel lines)
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• 7. Methylation (spark plugs)

Lustig, METABOLICAL, Spring 2021
The Hateful (or Grateful) Eight

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- 1. Glycation (carbon deposits)
- 2. Oxidative Stress (rusting)
- 3. Mitochondrial Dysfunction (transmission)
- 4. Insulin Resistance (carburetor)
- 5. Membrane Integrity (oil leak)
- 6. Inflammation (rotted fuel lines)
- 7. Methylation (spark plugs)
- 8. Autophagy (oil sludge)

Lustig, METABOLICAL, Spring 2021
The Hateful (or Grateful) Eight

The Diseases That Aren’t Diseases

Subcellular Pathologies that Belie Aging

- 1. Glycation ---- carbohydrate, fructose, lack of fiber
- 2. Oxidative Stress ---- glucose, fructose, trans-fats
- 3. Mitochondrial Dysfunction --- fructose, omega-6’s, trans-fats, lack of micronutrients
- 4. Insulin Resistance --- fructose, branched chain amino acids
- 5. Membrane Integrity --- lack of omega-3’s
- 6. Inflammation ---- carbohydrate/gluten (in some), omega-6s, fructose, lack of fiber
- 7. Methylation --- lack of folic acid, \(B_6, B_{12}\)
- 8. Autophagy --- frequent feeding, lack of fiber

None of these are “druggable”

But they are all “foodable”

Lustig, METABOLICAL, Spring 2021
The Hateful (or Grateful) Eight

The Diseases That Aren’t Diseases
Subcellular Pathologies that Belie Aging

• 1. Glycation ---- NOT amenable to exercise
• 2. Oxidative Stress ---- NOT amenable to exercise
• 3. Mitochondrial Dysfunction
• 4. Insulin Resistance
• 5. Membrane Integrity ---- NOT amenable to exercise
• 6. Inflammation
• 7. Methylation ---- NOT amenable to exercise
• 8. Autophagy

“You can’t outrun a bad diet”
Why Ultra-Processed Foods Are So Bad for You

Recent research finds that highly processed food may pose health risks.

TARA LAW
JAN 09, 2023 9:06 AM PST
Is ultraprocessed food “food”? 
Is ultraprocessed food “food”? 

Food: Substrate that contributes either to the burning or growth of an organism.
"The most important takeaway of this study is that high fructose in the diet is bad," says Dr. Kahn. "It’s not bad because it’s more calories, but because it has effects on liver metabolism to make it worse at burning fat. As a result, adding fructose to the diet makes the liver store more fat, and this is bad for the liver and bad for whole body metabolism."

Dr. C. Ronald Kahn, CEO
Joslin Diabetes Center
Growth:
Ultraprocessed food inhibits bone growth

Control vs. UPF+CSD

D. Mechanical properties

<table>
<thead>
<tr>
<th>Tested parameter</th>
<th>Control</th>
<th>UPF+CSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stiffness (N/mm)</td>
<td>393.5 ± 58.9</td>
<td>103.5 ± 40.6*</td>
</tr>
<tr>
<td>Yield (N)</td>
<td>57.7 ± 6.4</td>
<td>27.0 ± 4.0*</td>
</tr>
<tr>
<td>Fracture load (N)</td>
<td>94.7 ± 10.5</td>
<td>24.7 ± 4.5*</td>
</tr>
<tr>
<td>Max load (N)</td>
<td>110.9 ± 10.1</td>
<td>37.8 ± 6.4*</td>
</tr>
</tbody>
</table>

UPF: Ultraprocessed food
CSD: Caloric soft drink

Consumption of ultra-processed foods associated with weight gain and obesity in adults: A multi-national cohort study

Reynalda Cordova a, b, Nathalie Kliemann a, Inge Huybrechts a, Fernanda Rauber c, d, Eszter P. Vamos e, Renata Bertazzi Levy c, d, Karl-Heinz Wagner b, Vivian Viallon a, Corinne Casagrande a, Geneviève Nicolas a, Christina C. Dahm f, Jie Zhang f, Jytte Halkjær g, Anne Tjønneland g, h, Marie-Christine Boutron-Ruault i, j, Francesca Romana Mancini i, j, Nasser Laouali i, j, Verena Katzke k, Bernard Srour k, Franziska Jannasch l, m, n, Matthias B. Schulze l, o, Giovanna Masala p, Sara Grioni q, Salvatore Panico r, Yvonne T. van der Schouw s, Jeroen W.G. Derksen s, Charlotte Rylander t, Guri Skeie t, Paula Jakszyn u, v, Miguel Rodriguez-Barranco w, x, y, José María Huerta z, aa, Aurelio Barricarte y, ab, ac, Louise Brunkwall ad, Stina Ramne ad, Stina Bodén ae, Aurora Perez-Cornago af, Alicia K. Heath e, Paolo Vineis e, Elisabete Weiderpass a, Carlos Augusto Monteiro c, d, Marc J. Gunter a, Christopher Millett e, Heinz Freisling a, *
Ultra-Processed Food Consumption Associated with Incident Hypertension among Chinese Adults—Results from China Health and Nutrition Survey 1997–2015

Ming Li 1,* and Zumin Shi 2,**
Ultraprocessed Food Consumption and Risk of Type 2 Diabetes Among Participants of the NutriNet-Santé Prospective Cohort

Bernard Srour, PharmD, MPH, PhD; Léopold K. Fezeu, MD, PhD; Emmanuelle Kesse-Guyot, MSc, PhD; Benjamin Allès, PhD; Charlotte Debras, MSc; Nathalie Druesne-Pecollo, PhD; Eloi Chazelas, MSc; Mélanie Deschasaux, MSc, PhD; Serge Hercberg, MD, PhD; Pilar Galan, MD, PhD; Carlos A. Monteiro, MD, PhD; Chantal Julia, MD, MPH, PhD; Mathilde Touvier, PhD, MSc, MPH
Associations of ultra-processed food consumption with cardiovascular disease and all-cause mortality: UK Biobank

Xuanli Chen, Jiadong Chu, Wei Hu, Na Sun, Qida He, Siyuan Liu, Zhaolong Feng, Tongxing Li, Qiang Han, Yueping Shen
Association between ultra-processed foods consumption and risk of non-alcoholic fatty liver disease: a population-based analysis of NHANES 2011–2018

Zhening Liu, Hangkai Huang, Yan Zeng, Yishu Chen and Chengfu Xu*

Department of Gastroenterology, The First Affiliated Hospital, Zhejiang University School of Medicine, 79 Qingchun Road, Hangzhou 310003, People’s Republic of China
Ultra-processed food consumption and metabolic syndrome: a cross-sectional study in Quilombola communities of Alagoas, Brazil

Lídia Bezerra Barbosa¹², Nancy Borges Rodrigues Vasconcelos¹, Ewerton Amorim dos Santos³, Tamara Rodrigues dos Santos¹, Thays Ataide-Silva² and Haroldo da Silva Ferreira²
Intake of ultra-processed foods is associated with an increased risk of Crohn’s disease: a cross-sectional and prospective analysis of 187,154 participants in the UK Biobank

Jie Chen, Judith Wellens, Rahul Kalla, Tian Fu, Minzi Deng, Han Zhang, Shuai Yuan, Xiaoyan Wang, # Evropi Theodoratou, Xue Li, # Jack Satsangi,
Consumption of ultra-processed foods and cancer risk: results from NutriNet-Santé prospective cohort

Thibault Fiolet, Bernard Srour, Laury Sellem, Emmanuelle Kesse-Guyot, Benjamin Allès, Caroline Méjean, Mélanie Deschasaux, Philippine Fassier, Paule Latino-Martel, Marie Beslay, Serge Hercberg, Céline Lavalette, Carlos A Monteiro, Chantal Julia, Mathilde Touvier
Association of Ultraprocessed Food Consumption With Risk of Dementia: A Prospective Cohort Study

Huiping Li, Shu Li, Hongxi Yang, Yuan Zhang, Shunming Zhang, Yue Ma, Yabing Hou, Xinyu Zhang, Kaijun Niu, Yan Borné, Yaogang Wang

First published July 27, 2022, DOI: https://doi.org/10.1212/WNL.0000000000200871
High ultra-processed food consumption is associated with elevated psychological distress as an indicator of depression in adults from the Melbourne Collaborative Cohort Study

Melissa M. Lane, Mojtaba Lotfaliany, Allison M. Hodge, Adrienne O’Neil, Nikolaj Travica, Felice N. Jacka, Tetyana Rocks, Priscila Machado, Malcolm Forbes, Deborah N. Ashtree, Wolfgang Marx
Premature Deaths Attributable to the Consumption of Ultraprocessed Foods in Brazil

Eduardo A.F. Nilson, ScD, Gerson Ferrari, PhD, Maria Laura C. Louzada, PhD, Renata B. Levy, PhD, Carlos A. Monteiro, PhD, Leandro F.M. Rezende, ScD
Ultra-processed food consumption and mental wellbeing outcomes

Rapid Report // September 2023
Global Mind Project (n = 227,000)

Figure 3: Impact of ultra-processed food consumption for different levels of exercise and income

Relationship between MHQ scores and frequency of ultra-processed food consumptions for individuals who (i) exercise several times a week (blue line) or less than once a week to never (red line) for the global sample (left) and (ii) for those who are low income (<$40,000 annually; red line) versus high income (>=$100,000 annually; blue line) for respondents in the United States (right)
NOVA I
Only NOVA IV correlates with chronic disease
57% of US consumption
73% of US food supply
Processed food and its role in nutritious and sustainable diets

Processed Food—An Experiment That Failed

Those of us who have participated in science know that 9 of every 10 experiments are failures. Now imagine that the last 50 years has been a grand clinical research experiment, with the American population as unwitting participants, conducted by 10 principal investigators—Coca-Cola, PepsiCo, Kraft, Unilever, General Mills, Nestlé, Mars, Kellogg, Proctor & Gamble, and Johnson & Johnson. In 1965, these corporations posed the hypothesis that processed food is better than real food. To determine if the experiment was a success or a failure, we have to examine the outcome variables. In this case, there are 4: food consumption, health/disease, environment, and cash flow, divided into companies, consumers, and society.

Processed food is defined by 7 food engineering criteria: it is mass produced, is consistent batch to batch, is consistent country to country, uses specialized ingredients from specialized companies, consists of preformed macronutrients, stays emulsified, and has long shelf life or freezer life. Furthermore, 11 nutritional properties distinguish processed food. (1) Too little fiber. When fiber (soluble and insoluble) is consumed within food, it forms a gelatinous barrier along the intestinal wall. This delays the intestine's ability to absorb nutrients, instead feeding the gut microbiome. Attenuation of the glucose rise results in insulin reduction. Attenuation of Fructose absorption reduces liver fat accumulation. (2) and (3) Too few ω-3 and too many ω-6 fatty acids. ω-3s are precursors to docosahexaenoic and eicosapentanoic acids (anti-inflammatory). Conversely, ω-6s are precursors of arachidonic acid (proinflammatory). The ratio of ω-6 to ω-3 fatty acids should be approximately 1:1. Currently, our ratio is about 25:1, favoring a proinflammatory state, which can drive oxidative stress and cell damage. (4) Too few micronutrients. Antioxidants, such as vitamins C and E, quench oxygen radicals in peroxisomes to prevent cellular damage, while others, such as carotenoids and α-lipoic acid, prevent lipid peroxidation. (5) Too many
1. 1790 — Sugar tariff

2. 1933 — Dust Bowl, Farm Bill, first food subsidies

3. 1959 — Fall of Bautista and rise of Castro in Cuba, altered sugar imports, Fanjul Bros.

4. 1971 — Richard Nixon and USDA Secretary Earl Butz, make food cheap, monoculture

5. 1977 — McGovern Commission, first Dietary Guidelines for Americans, fat is the enemy

6. 1980 — Hurricane Allen destroyed Caribbean sugar crop, HFCS given green light

7. 1986 — FDA reviews data on sugar, results “inconclusive”

8. 1990 — Nutrition Labeling and Education Act (NLEA), Nutrition Facts

9. 1994 — Dietary Supplement Health and Education Act (DSHEA), nutriceuticals

10. 1997 — Food Safety Modernization Act, Generally Recognized as Safe (GRAS) Loophole
Ultraprocessed foods are only “cheap” when the costs of their negative metabolic impact are externalized to health care and public health budgets.
The goal: Metabolic Health

The Strategies:

- Promote Metabolism
- Inhibit Inflammation
What is the definition of “healthy”?

• Michael Pollan said, “Eat Food. Not Too Much. Mostly Plants.“
• *Eat food:* Some need a low-fat diet, others need a high-fat diet.
• *Not too much:* Doesn’t take into account mitochondrial dysfunction.
• *Mostly plants:* Coke, Doritos, and Oreos are plant-based.
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• It’s not *what’s in the food*;
• It’s *what’s been done to the food*; and really,
• It’s *what they did to the food* that matters.
• And that’s not listed on the food label.
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• I suggest a different three principles:
Unprocessed food feeds the gut
Ultraprocessed food causes “leaky gut”
Short chain fatty acids
Fiber contributes to microbiome health

Healthy essential fats
Plant based, short chain, polyunsaturated fatty acids
Omega 3s: pregnancy, lifespan, childhood, ADHD, depression
Brain selective nutrients

Fructose reduction
Reduce glycemic load
Appropriate hydration
Reduce environmental toxins

The Metabolic Matrix
The Metabolic Matrix: Gut Health

- Digestion, Absorption, Metabolism
- Gut is an organ
- Unprocessed food feeds the gut
- Fiber
- Ultraprocessed food damages the gut
- Microbiome health
If you don’t feed your gut, your gut will feed on you
Higher dietary fiber content correlates with reduction in chronic disease

Soluble + Insoluble Fiber together protects the liver and feeds the gut:
- Acts as a barrier to sugar absorption
- Reduces insulin response
- Feeds the intestinal microbiome
- Induces the satiety signal sooner
- Colonic bacteria make short chain fatty acids
- Removes cancer cells from colon

Soluble Fiber alone:
- Feeds the intestinal microbiome
- Colonic bacteria make short chain fatty acids

Insoluble Fiber alone:
- Induces the satiety signal sooner
- Removes cancer cells from colon

Reynolds et al. Lancet 393: 434, 2019
Fiber is critical

- Supports healthy metabolism & regulates bowel movement through delayed gastric emptying
- Increases satiety
- Helps regulate blood glucose levels
- May help prevent certain cancers
- Lowers LDL (bad cholesterol)
- In Type 2 Diabetics, increasing fiber consumption may reduce fasting glucose and HbA1c
The Metabolic Matrix: Liver Health

- Fat Fraction Maps
- Fructose reduction, metabolism, etc.
- Reduce total sugar, glycemic load
- Fiber
- Appropriate hydration
- Reduce environmental toxins
- Intestinal barrier
The Metabolic Matrix: Protect the Liver

MRI Fat Fraction Maps

Fat, Metabolically Healthy
Low Liver Fat = 2.6%

Fat, Metabolically Ill
High Liver Fat = 24%

Thin, Metabolically Ill
High Liver Fat = 23%
Fructose is metabolized in the liver differently than glucose
De novo Lipogenesis
DNL

Glycerol-P

Ac CoA*
Malonyl CoA
Fatty Acid*

TG*

VLDL*

Lustig et al. Obesity 2016
Gugliucci et al. Atherosclerosis 2016
Schwarz et al. Gastroenterology 2017
Olson et al. Nutrients 2022
De novo Lipogenesis (DNL)

TG*

VLDL*

LIVER FAT

DNL

9 days fructose restriction

Ac CoA* → Malonyl CoA → Fatty Acid* → VLDL*

Glycerol-P

Lustig et al. Obesity 2016
Gugliucci et al. Atherosclerosis 2016
Schwarz et al. Gastroenterology 2017
Olson et al. Nutrients 2022
De novo Lipogenesis (DNL)

Ac CoA* → Malonyl CoA → Fatty Acid*

Glycerol-3-P → TG*

VLDL*

LIVER FAT

9 days fructose restriction

Improved Insulin kinetics

Lustig et al. Obesity 2016
Gugliucci et al. Atherosclerosis 2016
Schwarz et al. Gastroenterology 2017
Olson et al. Nutrients 2022
Tight junctions keep bad stuff out
Tight junctions keep bad stuff out

Gluten is a direct immunotoxin of zonulins, both in intestine AND brain—cause of Celiac Disease
Fructose also disrupts tight junctions, and lets bad stuff in

Sugar alters Th17 barrier in the intestine

Kawano et al., Cell 185, 1, 2022
1. Higher consumption of free sugars in active vs. inactive SLE
   (8.60% ± 5.51 vs. 6.36% ± 4.82; \( p = 0.020 \))
2. Association between consumption of free sugars and number of complications of SLE
Group A Streptococcus grow better with fructose than glucose

GAS responsible for psych disease:

1) Sydenham’s chorea
2) PANDAS
OCD
tic disorders
adult personality dis.
mood disorder

Orlovska et al. JAMA Pediatr. 74:740, 2017
Fructose and Cancer/Dementia

Perspective
“Sweet death”: Fructose as a metabolic toxin that targets the gut-liver axis

Mark A. Febbraio* and Michael Karin**
1Monash Institute of Pharmaceutical Sciences, Monash University, Parkville, VIC, Australia
2Department of Pharmacology, School of Medicine, University of California, San Diego, San Diego, CA, USA
*Correspondence: mark.febbraio@monash.edu (M.A.F.), mikarinnhealth.ucsd.edu (M.K.)
https://doi.org/10.1016/j.cmet.2021.09.004

Febbraio et al. Cell Metab 33:2316, 2021

Review
Fructose and fructose kinase in cancer and other pathologies

Hongfei Jiang1, Qian Lin1, Leina Ma2, Shudi Luo3, Xiaoming Jiang4, Jing Fang5, Zhimin Lu6

Jiang et al. J Genet Genom 48:531, 2021

Cerebral Fructose Metabolism as a Potential Mechanism Driving Alzheimer’s Disease

Richard J. Johnson1*, Fernando Gomez-Pinilla2, Maria Nagel3, Takahiko Nakagawa4, Bernardo Rodriguez-Irure5, Laura G. Sanchez-Lozada6, Dean R. Tolan6 and Miguel A. Lanaspa7

Johnson et al. Front Aging Neurosci 12:560865, 2020
Sugar is the marker for ultra-processed food
56% of the food sold in America is ultra-processed food
Accounts for 62% of the sugar in the American diet

Fig 2 | Relative contribution (%) of each food group to consumption of ultra-processed food in diet

Srour et al. BMJ 365:i1451, 2019
The Metabolic Matrix: Brain Health

• What is your brain made of?
• Healthy & essential fats
• Plant based, short chain, polyunsaturated fatty acids
• Balance of omega 3 & 6 in the brain
• Omega 6
• Omega 3s: pregnancy, lifespan, childhood
• ADHD and depression
• Brain selective nutrients
What is your brain made of?
The balance of omega-3 and omega-6 in the brain is critical.
Essential Fats: Metabolism and Dietary Sources

Omega-6 →

18:2n-6 linoleic acid, LA → Competition → FADS 1-2 →
20:4n-6, arachidonic acid, AA →
22:5n-6, DPA n-6

Meat, Organs

- Competition -

Omega-3 ↓

18:3n-3 alpha-linolenic acid, ALA → Seafood, Breast milk (DHA) →
20:5n-3 eicosapentaenoic acid, EPA → Series 3 Prostaglandins Thromboxanes Series 5 Leukotrienes →
22:6n-3, docosahexaenoic acid, DHA (brain, retina, testis)

Essential Fats: Metabolism and Dietary Sources

Series 2 Prostaglandins Thromboxanes Series 4 Leukotrienes

immune - metabolic - developmental responses

Soybean oil, Safflower oil, Corn oil

Flax, Canola Leaf plants
Poor psychiatric health is persistently linked to low omega-3

### Table 2: Fatty acid composition (％) of red blood cell data in adults with ADHD (n = 30)

<table>
<thead>
<tr>
<th></th>
<th>ADHD M</th>
<th>ADHD SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Omega 6</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c18: 2n-6 (LA)</td>
<td>13.95</td>
<td>1.62</td>
</tr>
<tr>
<td>c18: 3n6</td>
<td>0.08</td>
<td>0.03</td>
</tr>
<tr>
<td>c20: 2n6</td>
<td>0.30</td>
<td>0.05</td>
</tr>
<tr>
<td>c20:3n6</td>
<td>1.55</td>
<td>0.36</td>
</tr>
<tr>
<td>c20: 4n6 (AA)</td>
<td>13.71</td>
<td>1.35</td>
</tr>
<tr>
<td>c22: 4n6</td>
<td>3.67</td>
<td>0.53</td>
</tr>
<tr>
<td>c22: 5n6</td>
<td>0.53</td>
<td>0.10</td>
</tr>
<tr>
<td>Total n6</td>
<td>33.87</td>
<td>2.25</td>
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<tr>
<td><strong>Omega 3</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c18: 3n3 (ALA)</td>
<td>0.19</td>
<td>0.04</td>
</tr>
<tr>
<td>c20: 5n3 (EPA)</td>
<td>0.53</td>
<td>0.18</td>
</tr>
<tr>
<td>c22: 5n3</td>
<td>2.05</td>
<td>0.24</td>
</tr>
<tr>
<td>c22: 6n3 (DHA)</td>
<td>3.80</td>
<td>0.95</td>
</tr>
<tr>
<td>Total n3</td>
<td>6.57</td>
<td>1.22</td>
</tr>
</tbody>
</table>

Comparison of Means

n-3: $M = 5.63$, $SD = 1.25$

n-6: $M = 25.27$, $SD = 3.74$

The omega-3 index in Parletta et al (2016) study was 3.95% in comparison to the omega-3 index in NORAA participants which was 4.33%
ADHD and Depression

- Several meta-analyses have confirmed a small-modest effect size for reducing clinical symptoms of ADHD in children (see Hawkey & Niggs 2014, Clin Psychol Rev)
- Hallahan, Davis et al., Br J Psychiatry, 2016 confirmed an effect size of 0.61 (Cohens $d$) for reducing clinical depression – in both cases EPA-rich formulations had the greatest efficacy
Brain-selective nutrients
The Metabolic Matrix Explains What Nutrition Needs To Do

- The science is clear:
  - more soluble and insoluble fiber (to feed the gut)
  - less fructose (to protect the liver)
  - more α-linolenic acid, EPA, DHA (to support the brain)

- A Low Insulin Diet = A Real Food Diet

- The challenge is going from knowledge to transformation
  - We must "Debunk the Calorie", and promote metabolic health
**Eat Real Featured Meal**

**Housemade Baked Ziti**
Served with 100% whole grain pasta & freshly prepared marinara sauce

Why this matters?
Excess sugar negatively impacts your ability to learn.

Marinara sauce is made from scratch using minimally processed ingredients.

Why this matters?
This sauce is filled with nutritious whole food ingredients & does not contain any added sugar or other harmful additives found in pre-made sauces.

Seasonal strawberries and kiwis are sourced locally from Watsonville and Gridley respectively.

Why this matters?
Local sourcing of produce helps support businesses in our community and the planet's health.

The salad bar is stocked with a variety of fresh, local vegetables, including carrots from Bakersfield and romaine for Caesar salad from Salinas.

Why this matters?
Salad bars with fresh, local produce provide the opportunity to try a variety of fruits & vegetables.

Plain milk is nutrient rich and contains no added sugar.

Why this matters?
Excess sugar negatively impacts your ability to learn.

This meal showcases the values of our Eat Real Certification. Learn more at www.eatreal.org/walnut-creek-is-certified.

**WCSD Eat Real Certification Highlights**

- 66% of produce is sourced locally (34% increase from 2019)
- Removed an average of 7 lbs of added sugar per student per year from breakfast grains alone
- Nothing on menu contains more than 3 tsp of added sugar
- Increased plant-based menu options
  - From 0 to 5 at K-5 and K-8 sites
  - From 1 to 7 at 6-8 sites
- Saw lunch participation increase by 73% and breakfast by 2400% from 2019 to 2023
'Ultra-processed' products now half of all UK family food purchases

Exclusive: health experts warn increasing popularity of industrially-made food will lead to negative effects such as obesity and poor health

Sarah Boseley Health editor

Americans Are Eating More Ultra-Processed Foods: How to Cut Down on Them

57% of US consumption
73% of the US food supply
Strategies for Advancing Metabolic Health

Public Health Intervention
(one population at a time)

Personal Intervention
(one patient at a time)

Technological Innovation
(one company at a time)