CHOLINE: EXPLORING THE GROWING SCIENCE ON ITS BENEFITS FOR MOMS, DURING FETAL DEVELOPMENT AND BEYOND

Wednesday, September 12, 2018

Marie Caudill, PhD, RD
Elizabeth Ward, MS, RD
Marie Caudill, PhD, RD
Professor, Division of Nutritional Sciences at Cornell University

- Internationally recognized expert known for her work on folate and choline
- Research focuses primarily on choline and the level of intake required to meet metabolic requirements and improve physiological outcomes
- Published more than 100 papers, reviews or chapters in this area and is an editor on the popular graduate level textbook "Biochemical, Physiological, & Molecular Aspects of Human Nutrition"
- Frequently invited to speak on topics related to methyl nutrients, one-carbon metabolism and nutritional genomics
ELIZABETH WARD, MS, RD
CONSULTANT AND AUTHOR

- Award-winning author, nutrition consultant and spokesperson
- Author/co-author of seven books including her most recent, “Expect the Best, Your Guide to Healthy Eating Before, During and After Pregnancy, 2nd ed.”
- Frequently writes for several top-tier publications and maintains a website, Betteristhenewperfect.com
- Previously a spokesperson for the Academy of Nutrition and Dietetics for nine years and was a writer and contributing editor for Environmental Nutrition, and a writer for WebMD
- Counseled children, and pregnant women and other adults about healthy eating and disease prevention at Harvard Vanguard Medical Associates
- Expert advisor to the HP Hood company
LEARNING OBJECTIVES

1. Recognize the critical role choline plays in supporting positive health outcomes, particularly at important life stages such as during fetal development and beyond.

2. Translate scientific evidence into meaningful dietary recommendations to help boost choline intake.

3. Recommend foods and supplements that can help infants, women and other consumers improve choline intake to achieve research-backed health benefits.
CHOLINE IN THE LIFE CYCLE: THE ESSENTIAL NUTRIENT MORE PEOPLE NEED TO KNOW
STATE OF THE SCIENCE

MARIE A. CAUDILL, PHD, RD
DIVISION OF NUTRITIONAL SCIENCES
CORNELL UNIVERSITY
Grants/Research Support
- NIH, USDA, Balchem Corporation, Egg Nutrition Center, National Cattlemen’s Beef Association/Beef Checkoff

Other Financial or Material Support/Honorarium
- Balchem Corporation
WHAT DOES CHOLINE DO?

Phosphatidylcholine (PC)

VLDL Fat Export

Membrane Biosynthesis
WHAT DOES CHOLINE DO?

Acetylcholine
WHAT DOES CHOLINE DO?

Methyl Donor

SAM + Choline = DNA Methylation

Creatine
Phospholipids
Hormones
Neurotransmitters
CHOLINE PLAYS A FUNDAMENTAL ROLE IN HUMAN HEALTH ACROSS THE LIFE CYCLE
LARGE AMOUNTS OF CHOLINE ARE REQUIRED DURING PREGNANCY

- Fetal Growth
- Brain Development
- DNA Methylation

- Learning
- Memory
- Attention

Proteins
Hormones
Metabolites

Cellular Function

Lasting Effects on Health
HIGHER MATERNAL CHOLINE INTAKE REDUCES RISK OF NEURAL TUBE DEFECTS

HIGHER MATERNAL CHOLINE INTAKE EASES BABY’S RESPONSE TO STRESS

LOWER PRODUCTION OF CORTISOL IN “CHOLINE BABIES” MAY REDUCE RISK OF STRESS-RELATED DISEASES

- Hypertension
- Obesity
- Diabetes
- Depression

- Memory
- Learning
- Attention

“Choline” Baby

In PE, placenta produces too much sFLT1


HIGHER MATERNAL CHOLINE INTAKE LOWERS PREECLAMPSIA RISK FACTOR
HIGHER MATERNAL CHOLINE INTAKE LOWERS PREECLAMPSIA RISK FACTOR

In PE, placenta produces too much sFLT1

HIGHER MATERNAL CHOLINE INTAKE IMPROVES OFFSPRING COGNITIVE FUNCTIONING (ANIMALS)

CON = control; SUP = supplementation.
Administered a visual attention task to measure eye movement reaction time to sequences of briefly presented visual stimuli.
COGNITIVE ASSESSMENT IN THESE CHILDREN AT AGE 7 REVEAL LASTING BENEFITS OF THE HIGHER MATERNAL CHOLINE INTAKE

• Attention
• Memory
• Problem Solving

ASN 2018
Abstract Submission ID: 424013
Abstract Title: “Enduring benefits of prenatal choline supplementation in 7-year olds: enhanced attention task performance”
Presenting Author: Charlotte Bahnfleth
Oral Session Title: “Nutritional Implications for Brain and Cognition” (Oral 11)
Oral Session Date: Sunday, June 10, 2018
Oral Session Time: 10:30 AM - 12:30 PM
Oral Session Location: Hynes Convention Center, Room 210
CHOLINE-DHA SYNERGY: A WAY TO INCREASE FETAL DHA SUPPLY?

Studies are being conducted in pregnant women to address this important question.

Only 10 percent of US pregnant women are meeting the choline AI

- Choline AI is 450 mg/d
- Average choline intake is ~300-350 mg/d
- Common genetic variants increase choline requirements
  *(further increasing gap between choline needs and intake)*

<table>
<thead>
<tr>
<th>Population and Age</th>
<th>Adequate Intake</th>
<th>Tolerable Upper Limit (UL)</th>
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</thead>
<tbody>
<tr>
<td>Infants, mo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–6</td>
<td>125 mg/d, 18 mg/kg</td>
<td>Not possible to establish</td>
</tr>
<tr>
<td>6–12</td>
<td>150 mg/d</td>
<td>Not possible to establish</td>
</tr>
<tr>
<td>Children, y</td>
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<td></td>
</tr>
<tr>
<td>1–3</td>
<td>200 mg/d</td>
<td>1,000 mg/d</td>
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<tr>
<td>4–8</td>
<td>250 mg/d</td>
<td>1,000 mg/d</td>
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<tr>
<td>9–13</td>
<td>375 mg/d</td>
<td>2,000 mg/d</td>
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<tr>
<td>Men, y</td>
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<td></td>
</tr>
<tr>
<td>14–18</td>
<td>550 mg/d</td>
<td>3,000 mg/d</td>
</tr>
<tr>
<td>≥19</td>
<td>550 mg/d</td>
<td>3,500 mg/d</td>
</tr>
<tr>
<td>Women, y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14–18</td>
<td>400 mg/d</td>
<td>3,000 mg/d</td>
</tr>
<tr>
<td>≥19</td>
<td>425 mg/d</td>
<td>3,500 mg/d</td>
</tr>
<tr>
<td>Pregnant</td>
<td>450 mg/d</td>
<td>Age-appropriate UL</td>
</tr>
<tr>
<td>Lactating</td>
<td>550 mg/d</td>
<td>Age-appropriate UL</td>
</tr>
</tbody>
</table>

Data from the Institute of Medicine, National Academy of Sciences.\textsuperscript{11}
VERY FEW OF THE MOST RECOGNIZED PRENATAL OR MULTIVITAMINS CONTAIN THE RECOMMENDED AMOUNT OF CHOLINE
THE AMERICAN MEDICAL ASSOCIATION (AMA) RECENTLY ANNOUNCED IT WILL SUPPORT ACTIONS TO BOOST CHOLINE AMOUNTS IN PRENATAL VITAMINS!

AMA Wire

AMA backs global health experts in calling infertility a disease
JUN 3, 2017

Sara Berg
Senior Staff Writer
AMA Wire

More than one in eight couples of childbearing age have difficulty conceiving or carrying a pregnancy to term, according to the Centers for Disease Control and Prevention. Experts at the World Health Organization (WHO) and the American Society for Reproductive Medicine (ASRM) have designated infertility a disease.

Delegates at the 2017 AMA Annual Meeting voted in support of WHO’s designation of infertility as a disease. The declaration could have a broader impact on how patients, insurers and society conceive of and act with regard to infertility.

Many factors at play
Causes of infertility are present in both men and women, with about 40 percent of all infertile couples demonstrating a combination of factors. And in about 13 percent of couples, no physiological dysfunction can be identified, making a definite diagnosis difficult. Infertility in both men and women leads to a decline in many quality-of-life metrics, including depression, shame, guilt, inadequacy and social isolation. Early treatment of infertility improves these metrics and the overall prospects of pregnancy, according to data provided in the resolution adopted by the AMA House of Delegates (HOD).

Prenatal supplementation
Those patients who do conceive, by any method, now have new advice from the AMA on proper prenatal vitamin supplementation.

Adequate levels of choline—an important nutrient that helps a baby’s brain and spinal cord to develop properly—are necessary to maintain normal pregnancy including neural development of the fetus and reducing the incidence of brain defects.

Inadequate choline levels during pregnancy are thought to negatively affect cognitive development. Neural tube and hippocampus development also are dependent on adequate choline intake.

Prenatal vitamins only contain 0–55 mg of choline, leaving the majority of pregnant and lactating women without enough dietary choline to protect the health and development of their babies, according to data cited in a resolution adopted by the HOD.

Delegates voted to support evidence-based amounts of choline in all prenatal vitamins.

Read more news coverage from the 2017 AMA Annual Meeting.
THE AMERICAN ACADEMY OF PEDIATRICS RECENTLY RECOGNIZED CHOLINE AS A KEY NUTRIENT TO SUPPORT NEURODEVELOPMENT DURING THE FIRST 1,000 DAYS
Key Takeaways

- Large amounts of choline are required for normal fetal and neonatal development.
- Higher maternal choline intake will likely improve pregnancy outcomes and offspring health.
- Most pregnant and lactating women need to increase dietary choline intake or consume a choline supplement to meet recommendations.
HEALTH PROFESSIONALS AND CHOLINE COMMUNICATION: WHERE DO WE STAND?

ELIZABETH WARD, MS, RD
Other Financial or Material Support/Honorarium

- Balchem Corporation
MOST AMERICANS DO NOT ACHIEVE ADEQUATE INTAKE FOR CHOLINE

Source: http://cholinecouncil.com/health_professional/
The 2015–2020 Dietary Guidelines for Americans Advisory Committee (DGAC) identified four nutrients with an Adequate Intake (AI) - vitamin K, fiber, potassium, and choline – that are under-consumed by children and adults.
Of the four, only fiber and potassium were called out in the DGA as nutrients of public health concern.

In addition, almost all of the USDA Healthy U.S.-Style Eating patterns included in the 2015-2020 DGA lack adequate choline.

- They also lack potassium, and vitamins D and E.

Federal food and nutrition health policies and programs are based on the DGA. For example:

- The Special Supplemental Nutrition Program for Women, Infants and Children uses DGA to determine the contents of its food packages and nutrition education program.

- The USDA’s National School Lunch Program and School Breakfast Program, which feeds more than 30 million children each school day, are informed by the DGA.

THE CHOLINE GAP: WHY?

- Vegans
- Vegetarians
- Mainstream eaters
- Pregnant and breastfeeding women with any of these eating styles
- Pregnant women with aversions to foods that are rich in choline
SELECTED CHOLINE SOURCES

- Egg yolk, large: 147 mg
- Ground beef, 3 oz. cooked: 85 mg
- Pork tenderloin, 3 oz. cooked: 83 mg
- Salmon, Atlantic, farmed, 3 oz. cooked: 77 mg
- Chicken breast, boneless, skinless, 3 oz. cooked: 65 mg
- Soybeans, ¼ cup roasted: 53 mg
- Broccoli, 1 cup cooked: 51 mg
- Garbanzo beans, ½ cup cooked: 35 mg

CREATING A CHOLINE-CENTRIC MEAL PATTERN

![Choline Diagram](image-url)
CREATING A CHOLINE-CENTRIC MEAL PATTERN

**CHOLINE for a Healthy Pregnancy**

CHOLINE-FOCUSED PREGNANCY EATING PATTERN

<table>
<thead>
<tr>
<th>PREGNANCY EATING PATTERN</th>
<th>CHOLINE-FOCUSED PREGNANCY EATING PATTERN</th>
</tr>
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<tbody>
<tr>
<td>1 cup mostly whole grain per meal</td>
<td>1 cup cooked rice</td>
</tr>
<tr>
<td>1 low-fat milk</td>
<td>1 egg, low-fat milk</td>
</tr>
<tr>
<td>1 cup cooked beans</td>
<td>1 oz of nuts or seeds</td>
</tr>
<tr>
<td>1 low-fat dairy</td>
<td>1 low-fat dairy</td>
</tr>
<tr>
<td>2 or more green veg</td>
<td>2 or more green veg</td>
</tr>
<tr>
<td>1 or more fruit</td>
<td>1 or more fruit</td>
</tr>
<tr>
<td>1 oz of nuts or seeds</td>
<td>1 oz of nuts or seeds</td>
</tr>
</tbody>
</table>

**MEDITERRANEAN-STYLE DIET**

- 3/4 cup cooked rice
- 1/2 cup cooked beans
- 1/2 cup cooked vegetables
- 1/2 cup cooked pasta
- 1/4 cup olive oil

**CHOLINE-FOCUSED MEDITERRANEAN-STYLE DIET**

- 1 egg, low-fat milk
- 1 oz of nuts or seeds
- 1 low-fat dairy
- 1 oz of nuts or seeds
- 1 low-fat dairy

**VEGETARIAN DIET**

- 1/2 cup cooked rice
- 1/2 cup cooked beans
- 1/2 cup cooked vegetables
- 1/2 cup cooked pasta
- 1/4 cup olive oil

**CHOLINE-FOCUSED VEGETARIAN DIET**

- 1 egg, low-fat milk
- 1 oz of nuts or seeds
- 1 low-fat dairy
- 1 low-fat dairy
- 1 low-fat dairy

Consult a doctor or registered dietitian for personalized nutrition needs during pregnancy.

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**CHOLINE in a Healthy Mediterranean-Style Diet**

The U.S. Healthy Mediterranean-style eating patterns are one of three eating patterns recommended by the 2015-2020 Dietary Guidelines for Americans. It's especially important to plant-based foods such as fruits, vegetables, legumes, and whole grains. To meet the nutrient needs of a healthy lifestyle, choline is recommended to be included. It is important to eat a variety of foods to meet nutrient needs. It is recommended to meet the requirement of 600 mg of choline each day. Consider smart swaps to get the most choline in a healthy, balanced Mediterranean-style diet for optimal health.

**CHOLINE in a Healthy Vegetarian Diet**

The U.S. Healthy Vegetarian Eating Pattern is one of three eating patterns included in the 2015-2020 Dietary Guidelines for Americans that are based on the Dietary Guidelines for Americans. It is recommended to meet the nutrient needs of a healthy lifestyle, choline is recommended to be included. It is important to eat a variety of foods to meet nutrient needs. It is recommended to meet the requirement of 600 mg of choline each day. Consider smart swaps to get the most choline in a healthy, balanced vegetarian diet for optimal health.

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**MEDITERRANEAN-STYLE DIET**

- 3/4 cup cooked rice
- 1/2 cup cooked beans
- 1/2 cup cooked vegetables
- 1/2 cup cooked pasta
- 1/4 cup olive oil

**CHOLINE-FOCUSED MEDITERRANEAN-STYLE DIET**

- 1 egg, low-fat milk
- 1 oz of nuts or seeds
- 1 low-fat dairy
- 1 oz of nuts or seeds
- 1 low-fat dairy

**VEGETARIAN DIET**

- 1/2 cup cooked rice
- 1/2 cup cooked beans
- 1/2 cup cooked vegetables
- 1/2 cup cooked pasta
- 1/4 cup olive oil

**CHOLINE-FOCUSED VEGETARIAN DIET**

- 1 egg, low-fat milk
- 1 oz of nuts or seeds
- 1 low-fat dairy
- 1 low-fat dairy
- 1 low-fat dairy

It can be difficult to meet daily choline needs, especially when following a choline-focused diet. Consider a supplement to meet the recommended 600 mg of choline each day.
“Nutritional needs should be met primarily from foods. … Foods in nutrient-dense forms contain essential vitamins and minerals and also dietary fiber and other naturally occurring substances that may have positive health effects. In some cases, fortified foods and dietary supplements may be useful in providing one or more nutrients that otherwise may be consumed in less-than-recommended amounts.”

Source: 2015-2020 Dietary Guidelines for Americans
The FDA has set the Reference Daily Intake (RDI) for choline at 550 mg.

Food labeling of choline content is voluntary.

Foods with at least 55 mg of choline per serving are considered a “good source” of the nutrient.

Helpful in educating consumers about choline, and aiding them in selecting foods that supply it.

CHOLINE IS IN SOME MULTIVITAMINS, BUT IN SMALL AMOUNTS
RECOMMENDATION FOR PATIENTS

Multivitamin + Choline

Multivitamin (as needed) may help maintain cellular health. Choline 550 mg per serving may help maintain cellular health.

For full prescribing information, see the package insert or go to www.urmp.org.
SELECTING A CHOLINE SUPPLEMENT

Choline upper level of tolerance = 3,500 mg/d

1 capsule = 300 mg choline
1 tablet = 500 mg choline
1 softgel = 50 mg choline

Only contains 13% choline based on weight
SPECIAL CONSIDERATIONS FOR CHOLINE: LACTATION

- Mammary cells are capable of uptake of choline from the maternal blood supply for transfer to the child.
- Choline levels in breast milk are highest in mature milk.
- Infant formula contains choline.
CHOLINE FOR LIFE

- Encourage choline-abundant foods. Pay particular attention to pregnant/lactating patients and those with vegetarian/vegan diets.
- Evaluate each person for their usual intake, and fill in the gap with supplements.
COMMUNICATING “CHOLINE FOR LIFE”

Choline is important for mom and baby, and for everyone else in the family, too, and at every age.
FOR MORE INFORMATION ON THE BENEFITS OF CHOLINE AT ALL AGES AND STAGES OF LIFE...

Visit: VitaCholine.com

THE CHOLINE CONNECTION
QUARTERLY RESEARCH, RESOURCES AND NEWS
MAY 2018

Choline Buzz

Summer is almost here and choline is hot! Choline supplements are easier to find now that Walmart and Target are carrying them. With nine out of ten Americans not meeting daily choline needs, these supplements can help fill the gap, along with a healthy, balanced eating pattern.

To learn more about choline’s role in health, mark your calendar for a FREE webinar we’re sponsoring with the Women’s Health Dietetic Practice Group of The Academy of Nutrition and Dietetics on Wednesday, June 6 from 12 pm – 2 pm (CDT). The webinar will feature Marie Caustie, PhD, RD, from Cornell University, who will present her research on choline’s role during pregnancy and the first 1,000 days, as well as Elizabeth Ward, MS, RD, who will translate the evidence into meaningful recommendations for expectant women and young families. You can register for the webinar via this link. This activity is awarded 1 CDR credit.

Subscribe to VitaCholine’s quarterly e-newsletter – The Choline Connection
https://confirmsubscription.com/h/d/7189DEE61A851D3A
FOR MORE INFORMATION ON THE BENEFITS OF CHOLINE AT ALL AGES AND STAGES OF LIFE…

QUESTIONS?

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**Credit Claiming Instructions:**

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4. Download and print your certificate.

**Please Note:** If you access the Evaluation between 3-4 pm ET on 9/12, you may experience a slow connection due to a high volume of users.