Scientific evidence exists supporting a diet rich in high quality protein as an optimal strategy to improve appetite control, satiety, and promote body weight management across the lifespan. This article provides a brief summary of the current research examining the effects of protein quantity and timing of protein consumption, particularly at breakfast, as a potential strategy to prevent and/or treat obesity in America.

Protein Quantity
Most Americans consume adequate amounts of dietary protein at approximately 15% of daily caloric intake (1). Although this is sufficient to prevent nutrient deficiency diseases/conditions, additional benefits with respect to preventing and/or treating obesity may be experienced when protein is consumed above this amount.

In a recent meta-analysis, Wycherley et al. (2) found that energy restriction diets containing higher-protein quantities (ranging from 27-35% of daily intake) consistently led to greater reductions in body weight and fat mass while preserving lean mass compared to standard-protein diets (ranging from 16-21% of daily intake). Similar findings have also been shown during weight-maintenance following significant weight loss (3, 4). In these studies, increased dietary protein led to a lower percentage of weight re-gain compared to the standard-protein diets (3, 4). Furthermore, the majority of weight re-gained in the higher-protein diet was fat free mass, whereas the weight re-gained in the standard-protein diet was primarily fat mass (3, 4). One potential factor contributing to the greater weight loss/maintenance observed with these higher-protein diets includes the proposed improvements in appetite control and satiety, leading to voluntary reductions in food intake and negative energy balance.

Two long-term, ad libitum feeding studies have shown significant weight loss accompanied by voluntary reductions in daily intake of up to 450 kcal/d with the consumption of increased dietary protein (between 25-30% of daily intake) (5, 6). These findings are also supported by several acute meal studies reporting reductions in subsequent meal intake of up to 300 kcal following higher vs. standard-protein meals (7, 8).

Our lab has recently examined the post-meal physiological and perceptual markers of appetite and satiety as potential mechanisms. The consumption of a single, higher-protein meal (containing 25-30% protein) led to greater increases in perceived fullness along with greater reductions in perceived hunger vs. a standard-protein meal (7, 9). These responses were accompanied by increases...
A nutritionally sound diet, including both macronutrients (carbohydrate, protein, and fat) and micronutrients (vitamins and minerals), is important to attain and maintain a healthy weight, reduce the risk of chronic disease and promote overall health. For runners, good nutrition is also essential for optimal performance. Adequate nutrition provides fuel for your training and competitions, helps you avoid injuries and illness, maximizes your performance and assists in recovery from workouts.

**Energy Requirements**
Runners’ caloric needs are significantly higher than those who do not participate in sports. Restricting food intake is never the way to become a better runner. To best fuel for running activities, your body must have adequate stores of the macronutrients used for energy. To ensure that your body has adequate stores, you must eat and drink an adequate amount of calories each day. Your age, weight, activity, training conditions and non-training activity level all play a role in your daily needs.

**Carbohydrates**
Carbohydrates and fats are essential to fuel your exercise. With high intensity, longer duration exercise, muscle carbohydrate (glycogen) becomes the decisive factor. If your glycogen stores become too low, you will start to feel fatigued. As you train, your muscles will be able to store more glycogen and you will preferentially burn more fat as fuel, allowing you to run longer.

Achieving and maintaining optimal carbohydrate intake is important for training intensity, preventing hypoglycemia (low blood sugar) during your run, serving as a fuel source for working muscles and assisting in post-exercise recovery.

Recommendations for daily carbohydrate requirements in runners range from 2.7 to 4.5 grams per pound of body weight, but can be as high as 5.9 grams per pound of body weight depending on the length of your training sessions. Runners should consume 30 to 60 grams of carbohydrate every hour during training and competition to improve endurance.

**Protein**
Protein is important for muscle growth: it also aids in recovery and repair following muscle damage, red blood cell development, antibody production and the synthesis of new structures that improve your running, such as mitochondria and enzymes.

While non-athletes require 0.4 gram of protein per pound of body weight per day, recreational runners require 0.5 to 0.7 gram of protein per pound per day and competitive runners require up to 0.6 to 0.9 gram of protein per pound per day.

Protein should supply between 15 and 20% of your daily calories. More important than the total amount of protein is the need to consume consistent amounts of protein in multiple meals each day. New research emphasized the need for protein at breakfast for repair and development. Research also indicated the importance of protein after exercise to accelerate recovery. At least 15 grams of protein should be consumed within 2 hours of completing exercise to optimize repair and recovery.

Good protein sources include eggs, meats, poultry, fish, dairy products, nuts, seeds, peanut butter, soy foods, and beans. If you’re a vegan and avoid all animal proteins, increase your protein intake by an additional 10%.

**Fat**
Despite its bad rap, fat does have a role in a runner’s diet. Fat supplies fatty acids that supply energy, helps to produce hormones, contribute to nerve function and carries the fat-soluble vitamins A, D, E and K into your body. While carbohydrates are the preferred fuel source for running, your body does use fat during low- to moderate-intensity exercise. Fat should supply between 20 to 25% of your daily calories. Choose polyunsaturated or monounsaturated fats (soybean, sunflower, peanut and olive oils) over saturated fat whenever possible.

**Calcium and Vitamin D**
Calcium enhances the effects of exercise on bone mineral density, a factor in preventing bone loss and reducing fracture risk. Calcium deficiency is a contributing factor in the development of osteoporosis. A good method of estimating your dietary calcium intake is to multiply the number of servings of dairy per day by 300 mg.

Dairy products such as milk, yogurt, and cheese are excellent calcium sources. A one-cup serving of most dairy products contains 200 to 300 mg of calcium. Other good sources are canned salmon with bones and dark, leafy green vegetables, such as spinach, kale and broccoli, as well as fortified foods like orange juice, breads and cereals.

“New research emphasized the need for protein at breakfast for repair and development. Research also indicated the importance of protein after exercise to accelerate recovery.”

Continue on page 5.
The Effects of Protein Quantity and Timing of Consumption on Appetite Control, Satiety and Body Weight Management

in the satiety-hormone PYY and decreases in the hunger-hormone ghrelin \(^7,9\) . We also examined whether increased dietary protein, provided at every meal, would lead to sustained dietary alterations throughout the day. We found that the higher-protein meals (containing 25% protein) led to sustained increases in perceived fullness and PYY throughout the day and into the evening vs. the standard-protein meals. These data provide clear evidence supporting the role of increased dietary protein for improved appetite control, satiety and/or body weight management.

Timing of Protein Consumption

Since most Americans consume less protein than what appears to be ‘optimal,’ the next step is to determine how to incorporate additional protein into the diet. One potential target is breakfast, which is currently either very low in protein quantity or is skipped all-together.

“Since most Americans consume less protein than what appears to be ‘optimal,’ the next step is to determine how to incorporate the additional protein into the diet.”

We recently examined whether the addition of a higher-protein, egg-based breakfast leads to daily improvements in appetite control, satiety, food motivation/reward and energy intake compared to a standard-protein breakfast comprised of ready-to-eat cereals \(^8\). We found that the higher-protein breakfast led to greater increases in daily fullness and PYY vs. the standard-protein version. We also performed brain scans to detect neural activation in regions controlling food motivation/reward prior to dinner-time, which is the time in which most Americans begin to overeat. We found that the higher-protein breakfast reduced brain activation in regions controlling food motivation/reward vs. the standard-protein breakfast. Lastly, the higher-protein breakfast led to reductions in evening snacking, particularly of unhealthy, high fat foods vs. the standard-protein breakfast. Thus, the addition of protein at the breakfast meal appears to improve energy intake regulation throughout the day and into the evening.

Summary

Higher-protein diets, containing 25-30% of daily intake as protein, lead to significant weight loss and/or beneficial changes in body composition compared to standard-protein versions. The mechanism-of-action appears to be due, in part, to improvements in appetite control and satiety, leading to voluntary reductions in intake. The breakfast meal appears to be an ideal eating occasion for increased dietary protein due to the sustained effects throughout the day and into the evening hours. Collectively, these findings suggest that a higher-protein diet might be an optimal strategy to prevent and/or treat obesity in America.

References

10. Leidy HJ. Effects of increased dietary protein at breakfast on appetite control and energy intake throughout the day in overweight ‘breakfast skipping’ teen girls. Experimental Biology Annual Meeting; April, 2012; San Diego, CA.
Over the past fifty years, there has been a fair amount of misinformation about elevated serum cholesterol (lipids) and the role of dietary cholesterol causing elevated cholesterol. In 1961, The American Heart Association stated “Those people who have had one or more atherosclerotic heart attacks or strokes may reduce the possibility of recurrences by a change in diet.” This statement has been at least partially responsible for the decisions that people have made about their diets, though the statement appears to be based more on extrapolation rather than on actual data. Many European countries, as well as Australia, Canada, New Zealand, Korea and India, do not have any restrictions on cholesterol intake in their dietary guidelines.

Blood Cholesterol Facts
- The liver produces about 75% of circulating cholesterol while the other 25% of cholesterol comes from food.
- 100 million Americans have high cholesterol levels.
- Adults > age 20 should have cholesterol checked every 5 years.
- Diets high in saturated fat and trans-fats raise LDL cholesterol levels.

Goals for a Lipid Profile
Total Cholesterol < 200 mg/dl
HDL (Good cholesterol)--Men >40 mg/dl and Women >50 mg/dl
LDL (Bad cholesterol)--< 130 mg/dl but for patients with heart disease < 100 mg/dl
Ideal Cholesterol Ratio is 4:1 (divide Total Cholesterol by HDL)

Review of the literature
Many recent studies do not support the relationship between dietary cholesterol and CHD
- The Framingham Study as early as 1980 showed there was not a relationship between egg intake and cholesterol levels as well as no relationship between egg intake and the incidence of coronary heart disease.
- Nurses’ Health Study [n=80,082]--This study showed that dietary cholesterol was not related to an increased incidence of cardiovascular disease.
- National Health and Nutrition Examination Survey (NHANES) [n=27,378]--This study showed no relationship between egg intake and plasma cholesterol. Many of the persons in this study that consumed between one and four eggs daily had similar levels of blood cholesterol. Many of the people in this study who consumed between one and four eggs daily had similar levels of blood cholesterol.
- A study by Qureshi (2007) involving 9734 adults consuming 1-6 eggs per week showed that egg consumption was not associated with stroke, ischemia or CHD.

Summary: The majority of the studies over the last 20 years demonstrate a lack of relationship between dietary cholesterol and CHD risk in healthy populations.

Management of Lipid Disorders and Dietary Factors
- Restriction of caloric intake. Excessive caloric intake can lead to increased liver secretion of VLDL (very low density lipoprotein)
- Reduction of dietary fat intake. Even though dietary cholesterol has little effect on serum cholesterol in healthy people, reduction of saturated fats and trans-fats is helpful in reducing cardiovascular risk.
- Poly-unsaturated fats such as vegetable oils, safflower oil, corn oil, salmon, mackerel herring and trout can help reduce cholesterol levels.
- Mono-unsaturated fats can reduce LDL cholesterol levels and lower the risk of heart attack and stroke. Examples of these types of fats include olive oil, canola oil, sunflower oil, avocados, peanut butter, nuts and seeds.
- High carbohydrate intake can increase triglycerides and insulin resistance.
- Restriction of alcohol ingestion.
Nutritional Needs for Female Runners

Continue from page 2

Vitamin D also increases bone resorption to provide calcium from “old” bone to make “new” bone. Vitamin D is produced when skin is directly exposed to the sun. Unfortunately, dietary sources of vitamin D are limited to fortified foods, and natural sources like fatty fish and eggs. Because of the limited natural sources, however, vitamin D supplements are the best way to ensure adequate vitamin D stores.

Women age 19 years through 50 years require 1,000 milligrams per day of calcium and 600 International Units a day of vitamin D. Menopausal women and women older than 50 should ingest at least 1,200 milligrams per day of calcium and between 800 to 1,000 International Units per day of vitamin D.

Iron

Iron is essential for forming the oxygen-carrying compounds in blood (hemoglobin) and muscle (myoglobin). Oxygen-carrying capacity is essential for running. Without enough iron to produce red blood cells, a woman can develop anemia, a condition in which the body does not have enough red blood cells, which causes fatigue, poor recovery, and subpar performance. Iron deficiency results from diminished dietary iron intake, excessive iron losses (such as during menstrual cycle periods) or both.

Iron is found in animal foods, such as red meat and dark poultry and in dried fruit, dark greens, beans, whole grains, and soy foods.

Other Dietary Approaches to Lowering Serum Cholesterol

1. Increase intake of canned or dry beans, fresh fruits, whole grains, vegetables, walnuts, almonds and vegetable juice
2. Avoid trans-fat margarines. (Replacements—canola oil, olive oil or plant sterol spreads)
3. Red wine (women—5 ounces/men=10 ounces) or pure grape juice (women 8 ounces/men=16 ounces)
4. Cocoa consumption and dark chocolate (lowered LDL 5 mg/dl)

References


Nutrient Density

The Top 5 Foods to Improve Lipid Profiles

There are many foods that are helpful in lowering blood cholesterol and lipid levels. Some of the best foods helpful for reducing cholesterol include:

1. High soluble fiber foods
   - oatmeal, oat bran
2. Foods with Omega 3 fatty acids
   - salmon, tuna, shrimp, eggs and chicken
3. Polyunsaturated fats
   - walnuts, sunflower or corn oil
4. Monounsaturated fats
   - Olive oil, almonds, hazelnuts, pistachios, canola oil
5. Foods with added plant sterols or stanols
   - grains, vegetables, fruits, legumes, nuts, and seeds

Other Dietary Approaches to Lowering Serum Cholesterol

• Increase intake of canned or dry beans, fresh fruits, whole grains, vegetables, walnuts, almonds and vegetable juice
• Avoid trans-fat margarines. (Replacements—canola oil, olive oil or plant sterol spreads)
• Red wine (women—5 ounces/men=10 ounces) or pure grape juice (women 8 ounces/men=16 ounces)
• Cocoa consumption and dark chocolate (lowered LDL 5 mg/dl)

Messages

• Over the past fifty years, there has been a fair amount of misinformation about elevated cholesterol (lipids) and the role of food in causing elevated cholesterol.
• Majority of studies from last 20 years demonstrate lack of relationship between dietary cholesterol and CHD risk in healthy populations.

Messages

• For runners, good nutrition is also essential for optimal performance. Adequate nutrition provides fuel for your training and competitions, helps you avoid injuries and illness, maximizes performance and assists in recovery from workouts.
• More important than the total amount of protein is the need to consume consistent amounts of protein in multiple meals each day.
• Consume at least 15 grams of protein within 2 hours of completing exercise to optimize repair and recovery.
Effects of Varying Protein Diets on Weight Loss and Cardiometabolic Risk

There is much debate in the scientific community regarding macronutrient composition of weight loss diets, particularly with respect to the effects of carbohydrate and protein content on cardiometabolic risk. The American Journal of Clinical Nutrition recently published a meta-analysis of 24 studies comparing isocaloric, energy-restricted, low-fat diets with varying protein content in a total of 1,063 adults. In the analysis, study diets were classified as either standard protein (SP), ranging from 12-18% of energy or high protein (HP), or 25-35% of energy; all diets were lowfat, with less than 30% of calories from fat. On average, participants followed the diets for about 12 weeks. The researchers looked at the effects of these diets on weight loss, body composition, resting energy expenditure (REE), satiety and cardiometabolic risk factors. Through statistical analysis, the researchers discovered that compared with an energy-restricted, SP diet, an isocaloric HP diet resulted in greater weight loss and reduction in fat mass. Furthermore, the HP diet was shown to help mitigate the loss of fat-free mass (FFM) and a decrease in REE that typically occurs with weight reduction. While changes in fasting plasma glucose, fasting insulin, blood pressure and blood cholesterol levels did not vary significantly between the dietary treatments, the HP diet was also shown to produce greater reductions in plasma triglycerides. Participants in the HP group also reported greater feelings of satiety in several of the studies. The researchers concluded that a HP diet provides modest benefits for weight loss, particularly in protecting FFM and REE, but that long-term effects require further investigation.

References

Messages
- Study participants consuming 25-35% of calories as protein as part of a low-fat, weight loss diet experienced greater reductions in weight loss, fat mass and plasma triglycerides compared with individuals following standard protein, higher carbohydrate diets.
- Analysis showed that the high protein diets helped to mitigate the reductions in fat-free mass and resting energy expenditure typically observed in weight loss.
New Education Tool

Be sure to check out ENC’s newest education material “The Yolk: A Nutrient Goldmine”. It is housed in the Health Professional/Client/Patient Education Materials section of eggnutritioncenter.org.

There’s More to Eggs Than Just The Whites

While eggs are commonly associated with breakfast and protein, many individuals aren’t aware of the nutrient package the whole egg provides. This includes a variety of important vitamins and minerals required for the body to maintain health. These nutrients, a majority of which are found in the yolk, play key roles in many aspects of health at all ages, from supporting fetal development in pregnant women to helping protect brain health in older adults.

Additionally, enjoying an egg a day can fall within current cholesterol guidelines, particularly if individuals opt for other low-cholesterol foods throughout the day. In fact, the American Heart Association includes one medium egg in its list of healthy foods for under $1, making eggs an inexpensive and delicious way for individuals to get these nutrients.

What You Lose Without the Yolk

Eggs are packed with nutrients. One large egg has varying amounts of 13 essential vitamins and minerals—all for 70 calories. While egg whites contain some of the egg’s high-quality protein, riboflavin and selenium, when you skip the yolk, you lose at least a portion of the following:

- Phosphorous—Essential for the health and maintenance of body tissues, such as muscle
- Zinc—Important for normal functioning of all cells, important for brain development of healthy DNA, important in bone structure
- Thiamin—Vitamin B1 involved in nerve function, energy metabolism and synthesis of neurotransmitters
- Riboflavin—Vitamin B2 important for nutrient metabolism and normal function of the heart, muscles and nervous system
- Folate—Other sources: Milk and other dairy products, meat, fish, poultry
- Vitamin B12—Other sources: Meat, fish, poultry
- Selenium—Vitamin D required for nutrient metabolism and normal function of the heart, muscles and nervous system
- Iron—Other sources: Meat, fish, poultry
- Choline—Other sources: Fish, meats, fortified cereals and beans
- Vitamins B6, B2, folate, vitamin D and selenium

The Eggs You Lose

While eggs are often eaten with other foods that are high in calories and saturated fat, that doesn’t have to be the case. Eggs can be paired with almost any vegetable, making it easy to make half your plate fruits and vegetables. To build a balanced meal, add vegetables to easy egg dishes, such as frittatas, omelets or on toast. For more information on how to pair a nutritious meal, visit www.choosemyplate.gov.

Nutrition Close-Up

EGG NUTRIENTS

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Amount</th>
<th>% of RDA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>6 g</td>
<td>100%</td>
</tr>
<tr>
<td>Phosphorous</td>
<td>197 mg</td>
<td>25%</td>
</tr>
<tr>
<td>Zinc</td>
<td>1.24 mg</td>
<td>76%</td>
</tr>
<tr>
<td>Thiamin</td>
<td>0.15 mg</td>
<td>93%</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>0.17 mg</td>
<td>93%</td>
</tr>
<tr>
<td>Folate</td>
<td>70 mcg</td>
<td>100%</td>
</tr>
<tr>
<td>Vitamin B12</td>
<td>0.02 mcg</td>
<td>1%</td>
</tr>
<tr>
<td>Choline</td>
<td>112 mg</td>
<td>75%</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>4 mcg</td>
<td>100%</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>0.1 mcg</td>
<td>100%</td>
</tr>
<tr>
<td>Energy</td>
<td>72 calories</td>
<td>100%</td>
</tr>
</tbody>
</table>

Egg Nutrient Center • eggnutritioncenter.org

ENC Mission Statement:
ENC is a credible source of nutrition and health science information and the acknowledged leader in research and education related to eggs.

Nutrition Close-Up is a quarterly publication written and produced by the Egg Nutrition Center.

Nutrition Close-Up presents up-to-date reviews, summaries and commentaries focused on the role of diet in health promotion and disease prevention, including the contributions of eggs to a nutritious and healthful diet.