

Appendix E-1: Major Conclusions

SECTION 1: ENERGY BALANCE AND WEIGHT MANAGEMENT

Question 1: What Effects do the Food Environment and Dietary Behaviors Have on Body Weight?

Conclusion

An emerging body of evidence has documented the impact of the food environment and select behaviors on body weight in both children and adults. Moderately strong evidence now indicates that the food environment is associated with dietary intake, especially less consumption of vegetables and fruits and higher body weight. The presence of supermarkets in local neighborhoods and other sources of vegetables and fruits are associated with lower body mass index, especially for low-income Americans, while lack of supermarkets and long distances to supermarkets are associated with higher body mass index. Finally, limited but consistent evidence suggests that increased geographic density of fast food restaurants and convenience stores is also related to increased body mass index.

Strong and consistent evidence indicates that children and adults who eat fast food are at increased risk of weight gain, overweight, and obesity. The strongest documented relationship between fast food and obesity is when one or more fast-food meals are consumed per week. There is not enough evidence at this time to similarly evaluate eating out at other types of restaurants and risk of weight gain, overweight, and obesity. Strong evidence documents a positive relationship between portion size and body weight. Strong and consistent evidence in both children and adults shows that screen time is directly associated with increased overweight and obesity. The strongest association is with television screen time. Strong evidence shows that for adults who need or desire to lose weight, or who are maintaining body weight following weight loss, self-monitoring of food intake improves outcomes. Moderate evidence suggests that children who do not eat breakfast are at increased risk of overweight and obesity. The evidence is stronger for adolescents. There is inconsistent evidence that adults who skip breakfast are at increased risk for overweight and obesity. Limited and inconsistent evidence suggests that snacking is associated with increased body weight. Evidence is insufficient to determine whether frequency of eating has an effect on overweight and obesity in children and adults.

Implications

In order to reduce the obesity epidemic, actions must be taken to improve the food environment. Policy (local, state, and national) and private-sector efforts must be made to increase the availability of nutrient-dense foods for all Americans, especially for low-income Americans, through greater access to grocery stores, produce trucks, and farmers' markets, and greater financial incentives to purchase and prepare healthy foods. The restaurant and food industries are encouraged to offer foods in appropriate portion sizes that are low in calories, added sugars, and solid fat. Local zoning policies should be considered to reduce fast food restaurant placement near schools.

In addition, individuals can adopt a series of dietary behaviors:

- Individuals are encouraged to prepare, serve, and consume smaller portions at home and choose smaller portions of food while eating foods away from home.
- Children and adults are also encouraged to eat a healthy breakfast and to choose nutrient-dense, minimally processed foods whenever they snack.
- Children and adults should limit screen time, especially television viewing and not eat food while watching television. The American Academy of Pediatrics recommends no more than 1 to 2 hours per day of total media time for children and adolescents and discourages television viewing for children younger than age 2 years (AAP, 2001). A Healthy People 2010 objective is to increase the proportion of adolescents who view television 2 or fewer hours on a school day (HHS, 2000).
- Adults are encouraged to self-monitor body weight, food intake, and physical activity to improve outcomes when actively losing weight or maintaining body weight following weight loss. There is also evidence that self-monitoring of body weight and physical activity also improves outcomes when actively losing weight or maintaining bodyweight following weight loss (Butryn, 2007; Wing, 2006). In order to facilitate better self-monitoring of food intake, there needs to be increased availability of nutrition information at the point of purchase.
- Children and adults are encouraged to follow a frequency of eating that provides nutrient-dense foods within daily caloric requirements periodically through the day. Caution must be taken such that the frequency of eating does not lead to excess calorie intake but does meet nutrient needs.

Question 2: What is the Relationship between Maternal Weight Gain during Pregnancy and Maternal-Child Health?

Conclusion

Maternal weight gain during pregnancy outside the recommended ranges is associated with suboptimal maternal and child health. Women who gain weight excessively during pregnancy retain more weight after delivery, are more likely to undergo a cesarean section and to deliver large-for-gestational age newborns, and their offspring may be at increased risk of becoming obese later on in life. Women who gain weight below recommendations are more likely to deliver small-for-gestational age newborns.

Implications

Women are encouraged to maintain a healthy weight before conception. Additionally, women are encouraged to practice sound dietary and physical activity practices to help them attain gestational weight gain within the guidelines outlined by the IOM.

Question 3. What is the Relationship between Breastfeeding and Maternal Postpartum Weight Change?

Conclusion

A moderate body of consistent evidence shows that breastfeeding may be associated with maternal postpartum weight loss. However, this weight loss is small, transient, and depends on breastfeeding intensity and duration.

Implications

Transient weight loss has been associated with intensive breastfeeding. However, it is unlikely that breastfeeding currently plays a significant role in promoting more rapid postpartum maternal weight loss in the US given the small size of the effect, large inter-individual variability in maternal postpartum weight changes, and the fact that in the US, only one-third of women breastfeed exclusively at 3 months postpartum. Thus, breastfeeding should not be promoted as an effective maternal postpartum weight loss method.

Question 4: How is Dietary Intake Associated with Childhood Adiposity?

Conclusion

Evidence suggests that certain aspects of dietary intake are associated with greater or lesser adiposity in children. Moderately strong evidence from recent prospective cohort studies that identified plausible reports of energy intake support a positive association between total energy (caloric) intake and adiposity in children. Moderately strong evidence from methodologically rigorous longitudinal cohort studies of children and adolescents suggests that there is a positive association between dietary energy density and increased adiposity in children. Moderate evidence from prospective cohort studies suggests that increased intake of dietary fat is associated with greater adiposity in children; however, no studies were conducted under isocaloric conditions. Strong evidence supports the conclusion that greater intake of sugar-sweetened beverages is associated with increased adiposity in children. Moderate evidence suggests that there is not a relationship between intake of calcium and/or dairy (milk and milk products) and adiposity in children and adolescents. A limited body of evidence from longitudinal studies suggests that greater intake of fruits and/or vegetables may protect against increased adiposity in children and adolescents. Limited and inconsistent evidence suggests that for most children, intake of 100 percent fruit juice is not associated with increased adiposity, when consumed in amounts that are appropriate for age and energy needs of the child. However, intake of 100 percent juice has been prospectively associated with increased adiposity in children who are overweight or obese. There is insufficient evidence that dietary fiber is associated with adiposity in children.

Implications

Strategies to prevent childhood obesity should include efforts to reduce surplus energy intake, especially energy from foods and beverages that provide empty calories from added sugars and solid fats. Total fat intake should not exceed the IOM acceptable ranges, and should consist primarily of mono- and polyunsaturated fats that promote heart health and provide essential fatty acids for growth and development. Increasing consumption of vegetables and fruits in childhood is an

important public health goal, not only from the perspective of increasing intake of “shortfall” nutrients, but also because diets high in a variety of vegetables and fruits tend to be lower in energy density, and therefore likely to improve energy balance and prevent obesity. When consumed in moderation as part of a nutrient rich, energy-balanced diet, 100 percent juice can be a healthy part of a child’s diet. Children should be encouraged to consume recommended servings of low-fat dairy products daily in order to meet recommended dietary intake levels for key nutrients, such as calcium. Children should also be encouraged to consume greater amounts and varieties of high-fiber foods in order to increase nutrient density, and promote healthy lipid profiles, glucose tolerance, and normal gastrointestinal function. Consumption of sugar-sweetened beverages in childhood should be discouraged (1) because of the positive association with increased adiposity; and (2) because of the need to replace empty calories with nutrient- rich energy for optimal growth and development.

Question 5: What is the Relationship between Macronutrient Proportion and Body Weight in Adults?

Conclusion

There is strong and consistent evidence that when calorie intake is controlled, macronutrient proportion of the diet is not related to losing weight. A moderate body of evidence provides no data to suggest that any one macronutrient is more effective than any other for avoiding weight regain in weight reduced persons. A moderate body of evidence demonstrates that diets with less than 45% of calories as carbohydrates are not more successful for long-term weight loss (12 months). There is also some evidence that they may be less safe. In shorter-term studies, low calorie, high protein diets may result in greater weight loss, but these differences are not sustained over time. A moderate amount of evidence demonstrates that intake of dietary patterns with less than 45% calories from carbohydrate or more than 35% calories from protein are not more effective than other diets for weight loss or weight maintenance, are difficult to maintain over the long term, and may be less safe.

Implications

No optimal macronutrient proportion was identified for enhancing weight loss or weight maintenance. However, decreasing caloric intake led to increased weight loss and improved weight maintenance. Therefore, diets that are reduced in calories and have macronutrient proportions that are within the ranges recommended in the Dietary References Intakes (IOM, 2002/2005) (protein: 10%-35%; carbohydrate: 45%-65%; fat: 20%-35%) are appropriate for individuals who desire to lose weight or maintain weight loss. Diets that are less than 45 percent carbohydrate or more than 35 percent protein are difficult to adhere to, are not more effective than other calorie-controlled diets for weight loss and weight maintenance, and may pose health risk, and are therefore not recommended for weight loss or maintenance.

Question 6: Is Dietary Energy Density Associated with Weight Loss, Weight Maintenance, and Type 2 Diabetes Among Adults?

Conclusion

Strong and consistent evidence indicates that dietary patterns that are relatively low in energy density improve weight loss and weight maintenance among adults. Consistent but limited evidence suggests that lower energy density diets may be associated with lower risk of type 2 diabetes among adults.

Implications

Dietary patterns relatively low in energy density that have been associated with beneficial body weight outcomes also may be associated with lower risk of type 2 diabetes. They are characterized by a relatively high intake of vegetables, fruit, and total fiber and a relatively low intake of total fat, saturated fat, and added sugars (Kant and Graubard, 2005; Ledikwe, 2006a; Ledikwe, 2006b; Lindstrom, 2006; Murakami, 2007; Savage, 2008b; Wang, 2008). Additionally, lower dietary energy density may be associated with a dietary intake pattern characterized by lower consumption of meat and processed meats and energy-containing beverages (Wang, 2008). The Committee's conclusion applies to the whole dietary pattern, not to individual foods, and recognizes that a beneficial low-energy density dietary pattern can include consumption of some energy-dense foods (e.g., olive oil and nuts) that have been associated with improved health outcomes (see *Part D. Section 3: Fatty Acids and Cholesterol*).

Question 7: For Older Adults, What is the Effect of Weight Loss Versus Weight Maintenance on Selected Health Outcomes?

Conclusion

Weight loss in older adults has been associated with an increased risk of mortality, but because most studies have not differentiated between intentional versus unintentional weight loss, recommending intentional weight loss has not been possible. Recently, however, moderate evidence of a reduced risk of mortality with intentional weight loss in older persons has been published. Intentional weight loss among overweight and obese older adults, therefore, is recommended. In addition, with regard to morbidity, moderate evidence suggests that intentional weight loss in older adults has been associated with reduced development of type 2 diabetes and improved cardiovascular risk factors. There are insufficient data on cancer to come to a conclusion. Weight gain produces increased risk for several health outcomes.

Implications

Observational studies of weight loss, especially when intentionality cannot be rigorously established, may be misleading with respect to the effect of weight on mortality. Loss of weight is appropriate advice for elderly overweight/obese persons. Weight gain should be avoided.

Question 8: What is the Relationship between Physical Activity, Body Weight, and Other Health Outcomes?

Conclusion

Strong, consistent evidence indicates that physically active people are at reduced risk of becoming overweight or obese. Furthermore, there is strong evidence that physically active adults who are overweight or obese experience a variety of health benefits that are generally similar to those observed in people of ideal body weight. Because of the health benefits of physical activity that are independent of body weight classification, people of all body weight classifications gain health and fitness benefits by being habitually physically active.

In addition, strong and consistent evidence based on a wide range of well-conducted studies indicates that physically active people have higher levels of health-related fitness, lower risk of developing most chronic disabling medical conditions, and lower rates of various chronic diseases than do people who are inactive. The health benefits of being habitually active appear to apply to all people regardless of age, sex, race/ethnicity, socioeconomic status, and to people with physical or cognitive disabilities.

Implications

Americans are encouraged to meet the 2008 Physical Activity Guidelines for Americans. Children and adults should avoid inactivity. Some physical activity is better than none, and more is better. Achieving energy balance and a healthy weight depends on both energy intake and expenditure.

SECTION 2: NUTRIENT ADEQUACY

Question 1: What Nutrients and Dietary Components are Overconsumed by the General Public?

Conclusion

Estimated intakes of the following nutrients and dietary components are high enough to be of concern:

- For adults: total energy intake, particularly energy intake from solid fats and added sugars; sodium; percentage of total energy from saturated fats; total cholesterol (in men); and refined grains.
- For children: energy intake from solid fats and added sugars; sodium; percentage of total energy from saturated fats; total cholesterol (only in boys, aged 12 to 19 years); and refined grains.

Implications

To lower overall energy intakes (see *Part D. Section 1: Energy Balance and Weight Management*) without compromising nutrient intakes, Americans should reduce consumption of calories from solid fats and added sugars (SoFAS). SoFAS generally provide few, if any, micronutrients. Intakes of SoFAS should be kept as low as possible across all age-sex groups, to less than the maximum limits

calculated for the USDA Food Patterns. Concentrated efforts are needed to lower total sodium intakes by all Americans (see *Part D. Section 6: Sodium, Potassium, and Water*). Likewise deliberate public health efforts are warranted to reduce intakes of saturated fats to meet dietary guidelines for optimal health. Males older than age 12 years also are encouraged to consume less total dietary cholesterol (see *Part D. Section 3: Fatty Acids and Cholesterol*). Intakes of refined grain are too high and at least half of all refined grains should be replaced with high-fiber whole grains (see *Part D. Section 5: Carbohydrates*).

Question 2: What Food Groups and Selected Dietary Components are Underconsumed by the General Public?

Conclusion

Currently reported dietary intakes of the following food groups and selected dietary components are low enough to be of concern:

- For both adults and children: vegetables, fruits, whole grains, fluid milk and milk products, and oils.

Implications

Despite the evidence that health-promoting dietary patterns are those that include a variety of foods and combinations of foods from each of the basic food groups, many Americans make food choices that do not meet the characteristics of healthy dietary patterns (Bachman, 2008). A fundamental premise of the DGAC is that nutrients should come from foods. Often, nutrient intake shortfalls are an indicator of low intakes of certain food groups that provide specific nutrients. Hence, efforts are warranted to promote increased intakes of vegetables (especially dark-green vegetables, red-orange vegetables, and cooked dry beans and peas), fruits, whole grains, and fat-free or low-fat fluid milk and milk products (including calcium and vitamin D fortified soymilk) among all ages; substitution of oils for solid fats, regardless of age; and increased intakes of lean, heme-iron-rich meat, poultry, and fish by adult women and adolescent girls. Intake of nutrient-dense foods—that is, foods in their leanest or lowest fat forms and without added fats, sugars, starches, or sodium—should replace foods in the current American diet that contribute to high intakes of SoFAS and refined grains (see Question 1 on Nutrients and Dietary Components Overconsumed). Oils should only be substituted for solid fats rather than added to the diet. Substitutions and selection of nutrient-dense forms of vegetables, fruits, whole grains, and fluid milk and milk products to replace non-nutrient-dense forms of foods should be done in a manner such that total caloric intake falls within or below daily energy needs.

Question 3: What Nutrients are Underconsumed by the General Public and Present a Substantial Public Health Concern?

Conclusion

Reported dietary intakes and associated indices of nutrient status for the following nutrients are of public health concern:

- For both adults and children: vitamin D, calcium, potassium, and dietary fiber.

Implications

Efforts are warranted to promote increased dietary intakes of foods higher in vitamin D, calcium, potassium, and dietary fiber for all Americans regardless of age. Recommended intakes of these nutrients of concern, in particular, and of all essential nutrients, in general, should be achieved within the context of flexible dietary intake patterns that balance energy intake with energy expenditure.

Question 4: What is the Relationship between Folate Intake and Health Outcomes in the US and Canada Following Mandatory Folic Acid Fortification?

Conclusion

Strong and consistent evidence demonstrates a large reduction in the incidence of neural tube defects (NTDs) in the US and Canada following mandatory folic acid fortification. A limited body of evidence suggests stroke mortality has declined in the US and Canadian populations following mandatory folic acid fortification. A limited body of evidence suggests that mandatory folic acid fortification has increased the incidence of colorectal cancer (CRC) in the US and Canada.

Implications

Folic acid fortification in the US and Canada appears to be successful in the primary health objective of reducing the incidence of NTDs. Although some negative consequences appear to have occurred (i.e., possible increase in CRC), the evidence supports the continuation of folic acid fortification of flour and uncooked cereals at current levels (140 µg/100 g). Despite the increases in folic acid through fortification, about 22 percent of women of reproductive capacity still do not meet the Estimated Average Requirements. Women of reproductive capacity should continue to be counseled to select foods high in folate, and when necessary, take a folic acid supplement to meet their folate requirements. As a result of the increase in folic acid in food from fortification and because many adults take a supplement containing folic acid, approximately 5 percent of adults older than age 50 years now exceed the UL (1000 µg/day) for folic acid intake. To avoid exceeding the UL, adults over age 50 years should not supplement with folic acid in excess of 400 µg/day. Because whole grain foods are not always fortified with folic acid, individuals who consume mainly whole grains in their dietary patterns should ensure that some of these whole grains are fortified to achieve dietary folate recommendations.

Question 5: Is Iron a Nutrient of Special Concern for Women of Reproductive Capacity?

Conclusion

Substantial numbers of adolescent girls and women of reproductive capacity have laboratory evidence of iron deficiency.

Implications

Efforts are warranted to increase dietary intake of heme-iron-rich foods and of enhancers of iron absorption by these special populations.

Question 6: Are Older Adults Consuming Sufficient Vitamin B₁₂?

Conclusion

Recent evaluation of NHANES data shows that individuals older than age 50 years are consuming adequate intakes of vitamin B₁₂, including B₁₂ found naturally in foods and crystalline B₁₂ consumed in fortified foods. Nonetheless, a substantial proportion of individuals older than age 50 years may have reduced ability to absorb naturally occurring vitamin B₁₂ but not the crystalline form.

Implications

Although individuals older than age 50 years appear to be meeting their need for vitamin B₁₂, they should be encouraged to consume foods fortified with B₁₂, such as fortified cereals, or the crystalline form of B₁₂ supplements, when necessary. Practitioners should assess vitamin B₁₂ status in those older than age 65 years, using a low serum vitamin B₁₂ value of less than 300 pg/mL, high serum methylmalonic acid value of greater than 0.4 μmol/L, and serum total homocysteine level of greater than 15.0 μmol/L as evidence of vitamin B₁₂ deficiency.

Question 7: Can a Daily Multivitamin/Mineral Supplement Prevent Chronic Disease?

Conclusion

For the general, healthy population, there is no evidence to support a recommendation for the use of multivitamin/mineral supplements in the primary prevention of chronic disease. Limited evidence suggests that supplements containing combinations of certain nutrients are beneficial in reversing chronic disease when used by special populations; in contrast, certain nutrient supplements appear to be harmful in other subgroups.

Implications

Although intake of a variety of multivitamin/mineral supplements increase blood levels of many nutrients, notably in individuals with suboptimal nutrient status before supplementation (Maraini, 2009), long-term effects on primary prevention of several chronic diseases has not been demonstrated. In this context, obtaining essential micronutrients from foods when possible is the optimal approach and reliance on multivitamin/mineral supplements is discouraged. At present, Americans are encouraged to meet overall nutrient requirements within energy levels that balance daily energy intake with expenditure. This can be accomplished through a variety of food intake patterns that include nutrient-dense forms of foods.

Question 8: What is the Relationship between Nutrient Intake and Breakfast Consumption, Snacking, and Eating Frequency?

Conclusion

Moderate evidence supports a positive relationship between breakfast consumption and intakes of certain nutrients in children, adolescents, and adults. A limited body of evidence supports a positive relationship between snacking and increased nutrient intake in children, adolescents, adults, and older adults, and inadequate evidence is available to evaluate the relationship between eating frequency and nutrient intakes.

Implications

Americans are encouraged to eat nutrient-dense forms of foods for breakfast while staying within energy needs to facilitate achieving nutrient recommendations. Likewise nutrient-dense forms of foods are suggested for any snacks, if energy allowance permits this behavior without incurring weight gain.

SECTION 3: FATTY ACIDS AND CHOLESTEROL

Question 1. What is the Effect of Saturated Fat Intake on Increased Risk of Cardiovascular Disease or Type 2 Diabetes, Including Effects on Intermediate Markers such as Serum Lipid and Lipoprotein Levels?

Conclusion

Strong evidence indicates that intake of dietary saturated fatty acids (SFA) is positively associated with intermediate markers and end point health outcomes for two distinct metabolic pathways: 1) increased serum total and low-density lipoprotein (LDL) cholesterol and increased risk of cardiovascular disease (CVD) and 2) increased markers of insulin resistance and increased risk of type 2 diabetes (T2D). Conversely, decreased SFA intake improves measures of both CVD and T2D risk. The evidence shows that 5 percent energy decrease in SFA, replaced by monounsaturated fatty acids (MUFA) or polyunsaturated fatty acids (PUFA), decreases risk of CVD and T2D in healthy adults and improves insulin responsiveness in insulin resistant and T2D individuals.

Implications

As the evidence indicates that a 5 percent energy decrease in SFA, replaced by MUFA or PUFA, results in meaningful reduction of risk of CVD or T2D, and given that in the US population 11-12 percent of energy from SFA intake has remained unchanged for over 15 years, a reduction of this amount resulting in the goal of less than 7 percent energy from SFA should, if attained, have a significant public health impact. As an interim step toward this less than 7% goal, all individuals should immediately consume less than 10 percent of energy as saturated fats. This impact would not only be limited to a reduction in heart disease and stroke, but also in T2D, a disease currently rising in incidence and prevalence. This substitution of MUFA and PUFA for SFA assumes no change in energy intake. The age of onset of T2D is substantially younger than that of CVD and increasingly frequent in adolescence. Reduction in SFA in children and young adults may provide benefits

decades earlier than currently appreciated. The growing data to support a risk of T2D from SFA consumption supports the need for fat-modified diets in persons with pre-diabetes, including those with metabolic syndrome, and those with established diabetes. Early signs of atherosclerotic CVD are also seen in children and a number of studies indicate that the atherosclerotic process begins in childhood and is affected by high blood cholesterol levels. Therefore, reduction in SFA in children and young adults may provide benefits decades earlier than currently appreciated relative to both CVD and T2D incidence.

Question 2. What is the Effect of Dietary Cholesterol Intake on Risk of Cardiovascular Disease, Including Effects on Intermediate Markers such as Serum Lipid and Lipoprotein Levels and Inflammation?

Conclusion

Moderate evidence from epidemiologic studies relates dietary cholesterol intake to clinical CVD endpoints. Many randomized clinical trials on dietary cholesterol use eggs as the dietary source. Independent of other dietary factors, evidence suggests that consumption of one egg per day is not associated with risk of coronary heart disease (CHD) or stroke in healthy adults, although consumption of more than seven eggs per week has been associated with increased risk. An important distinction is that among individuals with T2D, increased dietary cholesterol intake is associated with CVD risk.

Implications

Overall, the evidence shows that consumption of dietary cholesterol in the amount of one egg per day is not harmful and does not result in negative changes in serum lipoprotein cholesterol and triglyceride levels. Neither does consumption of eggs at this level increase risk of CVD in healthy individuals. Eggs also are a good source of high quality protein and numerous micronutrients. However, in individuals with T2D, egg consumption (at one egg/day) does have negative effects on serum lipids and lipoprotein cholesterol levels and does increase risk of CVD. Furthermore, consumption of more than seven eggs per week is not recommended for the general public. Overall, limiting dietary cholesterol to less than 300 mg per day, with further reductions of dietary cholesterol to less than 200 mg per day for persons with or at high risk for CVD and T2D, is recommended.

Question 3. What is the Effect of Dietary Intake of MUFA when Substituted for SFA on Increased Risk of Cardiovascular Disease and Type 2 Diabetes, Including Intermediate Markers such as Lipid and Lipoprotein Levels and Inflammation? And What is the Effect of Replacing a High Carbohydrate Diet with a High MUFA Diet in Persons with Type 2 Diabetes?

Conclusion

Strong evidence indicates that dietary MUFA are associated with improved blood lipids related to both CVD and T2D when MUFA is a replacement for dietary SFA. The evidence shows that 5 percent energy replacement of SFA with MUFA decreases intermediate markers and the risk of

CVD and T2D in healthy adults and improves insulin responsiveness in insulin resistant and T2D subjects.

Moderate evidence indicates that increased MUFA intake, rather than high carbohydrate intake, may be beneficial for persons with T2D. High MUFA intake, when replacing a high carbohydrate intake, results in improved biomarkers of glucose tolerance and diabetic control.

Implications

At the current level of 11 to 12 percent of energy from SFA, healthy American adults would benefit substantially by replacing 5 percent of that total energy with MUFA (e.g., 12 percent SFA reduced to 7 percent SFA, 12 percent MUFA increased to 17 percent MUFA). Beneficial outcomes would include reduced rates of CVD and T2D as well as improved lipids and lipoproteins, inflammatory markers, and measures in insulin resistance. Persons with a predisposition to T2D or established T2D may especially benefit from a high MUFA diet, both as a substitute for SFA and as a substitute for carbohydrates. Given the high prevalence of T2D and the metabolic syndrome in the US, such benefits would have a large public health impact.

Question 4. What is the Effect of Dietary Intake of *n*-6 Polyunsaturated Fatty Acids on Risks of Cardiovascular Disease and Type 2 Diabetes, Including Intermediate Markers such as Lipid and Lipoprotein Levels and Inflammation?

Conclusion

Strong and consistent evidence indicates that dietary PUFA are associated with improved blood lipids related to CVD, in particular when PUFA is a replacement for dietary SFA or *trans* fatty acids. Evidence shows that energy replacement of SFA with PUFA decreases total cholesterol, LDL cholesterol and triglycerides, as well as numerous markers of inflammation. PUFA intake significantly decreases risk of CVD and has also been shown to decrease risk of T2D.

Implications

All recommendations assume an isocaloric replacement of SFA or *trans* fatty acids with PUFA. In this setting, both CVD and, potentially T2D, may be reduced with PUFA replacement. The mechanisms of CVD reduction, including improvement in serum lipid levels and reduced markers of inflammation, may have additional health benefits. PUFA consumption in the US is lower than that of SFA or MUFA, although the only essential fatty acids are PUFA, so a reduction of SFA from 12 percent to 7 percent of energy through an increase in PUFA alone would increase PUFA from 7 percent to 12 percent of energy. This, or replacing SFA with some combination of PUFA and MUFA, should yield significant public health benefits.

Question 5. What are the Effects of Dietary Stearic Acid on Low-density Lipoprotein Cholesterol?

Conclusion

Moderate evidence from a systematic review indicates that when stearic acid is substituted for other SFA or *trans* fatty acids¹, plasma LDL cholesterol levels are decreased; when substituted for carbohydrates, LDL cholesterol levels are unchanged; and when substituted for MUFA or PUFA, LDL cholesterol levels are increased. Therefore, the impact of stearic acid replacement of other energy sources is variable regarding LDL cholesterol, and the potential impact of changes in stearic acid intake on cardiovascular disease risk remains unclear.

Implications

Since stearic acid is not known to raise LDL cholesterol, the DGAC is recommending that stearic acid not be categorized with known “cholesterol-raising fats,” which include C12, C14, C16 SFA and *trans* fatty acids. Foods that are high in stearic acid, such as dark chocolate and shea nut oil, need not be considered as problematic as foods high in other SFA or *trans* fatty acids. In addition, setting the recommended percent of energy from these cholesterol-raising fats to a less than 5 to 7 percent will help to maintain blood cholesterol at desirable concentrations.

Question 6. What Effect does Consuming Natural (Ruminant) Versus Synthetic (Industrially Hydrogenated) Trans Fatty Acids have on LDL-, HDL- and Non HDL Cholesterol Levels?

Conclusion

Limited evidence is available to support a substantial biological difference in the detrimental effects of industrial *trans* fatty acids (iTFA) and ruminant *trans* fatty acids (rTFA) on health when rTFA is consumed at 7-10 times the normal level of consumption.

Implication

The level of daily intake of rTFA is quite small with the US adult population’s average daily intake approximating 1.2 g (1.5g for men and 0.9 g for women). This represents less than 2 percent of total daily energy intake. This is a relatively minor exposure in the diet regardless of its metabolic effect.

The very limited data available provide insufficient evidence to suggest rTFA and iTFA be considered differently in their metabolic effects. Total *trans* fatty acid intake should be considered the target for dietary change. Total elimination of rTFA would require elimination of red meat and dairy products from the diet. Although total elimination of iTFA may be desirable, the elimination of rTFA would have wider implications for dietary adequacy and is not recommended. It is best to avoid iTFA while leaving small amounts of rTFA in the diet. Overall, *trans* fatty acid levels in the US food supply have decreased dramatically following mandatory *trans* fatty acids labeling regulations, which went into effect in 2006. Continued reductions in iTFA are to be encouraged.

¹ *Trans* fatty acids as used in this Report refers to industrial *trans* fatty acids and is a term consistent with that defined by the US Food and Drug Administration for use in food labeling. See *Part D. Section 3: Fatty Acids and Cholesterol*.

Question 7. What is the Relationship Between Consumption of Seafood *n*-3 Fatty Acids and Risk of CVD?

Conclusion

Moderate evidence shows that consumption of two servings of seafood per week (4 oz per serving), which provide an average of 250 mg per day of long-chain *n*-3 fatty acids, is associated with reduced cardiac mortality from CHD or sudden death in persons with and without CVD.

Implications

An increase in seafood intake to two servings per week at 4 oz per serving, is advised for high-risk (those with CVD) and average-risk persons, especially as the first presentation of CVD (myocardial infarction, stroke) is frequently fatal or disabling. The quantity and frequency of seafood consumption is important, but the type of seafood (those providing at least 250 mg of long-chain *n*-3 fatty acids per day) also is critical. Increased consumption of seafood will require efficient and ecologically friendly strategies be developed to allow for greater consumption of seafood that is high in EPA and DHA, and low in environmental pollutants such as methyl mercury. (See *Part D.8: Food Safety and Technology* for a detailed discussion of the risks and benefits of seafood consumption).

Question 8. What is the Relationship between Consumption of Plant *n*-3 Fatty Acids and Risk of CVD?

Conclusion

Alpha-linolenic acid (ALA) intake of 0.6 - 1.2 percent of total calories will meet current recommendations and may lower CVD risk, but new evidence is insufficient to warrant greater intake beyond this level. Limited but supportive evidence suggests that higher intake of *n*-3 fatty acids from plant sources may reduce mortality among persons with existing CVD.

Implications

Evidence is currently insufficient to make a formal guideline to increase *n*-3 intake from plant sources without additional evidence from randomized clinical trials and prospective observational studies among participants with a broad range of *n*-3 intake. As relatively little ALA converts to EPA and DHA, evidence is lacking that plant-derived *n*-3 fatty acids alone will provide the same cardioprotective effects as EPA and DHA consumed at the recommended level discussed above. This increases the need for efficient and ecologically friendly strategies to allow for greater consumption of seafood *n*-3 fatty acids, unless plant-derived sources of EPA or DHA can be developed.

Question 9. What are the Effects of Maternal Dietary Intake of *n*-3 Fatty Acids from Seafood on Breast Milk Composition and Health Outcomes in Infants?

Conclusion

Moderate evidence indicates that increased maternal dietary intake of long chain *n*-3 PUFA, in particular docosahexaenoic acid (DHA) from at least 2 servings of seafood per week, during pregnancy and lactation is associated with increased DHA levels in breast milk and improved infant health outcomes, such as visual acuity and cognitive development.

Implications

There has been controversy and concern over the consumption of fish during pregnancy and lactation with regard to exposure of the fetus and infant to heavy metals during the most sensitive period of neurodevelopment. The current evidence, however, favors consumption of fish for pregnant and lactating women, particularly in the context of women making educated choices to consume seafood that is high in *n*-3 fatty acids and low in environmental pollutants. The benefits of fish consumption are maximized with fatty fish high in EPA and DHA but low in methyl mercury. These conclusions are consistent with those found in the discussion of seafood benefits and risks in *Part D.8: Food Safety and Technology*. The previously described modeling analysis of seafood identified scenarios of type and quantity of fish that provide 250 mg per day of EPA + DHA.

Question 10. What are the Health Effects Related to Consumption of Nuts?

Conclusion

There is moderate evidence that consumption of unsalted peanuts and tree nuts, specifically walnuts, almonds, and pistachios, in the context of a nutritionally adequate diet and when total calorie intake is held constant, has a favorable impact on cardiovascular disease risk factors, particularly serum lipid levels.

Implications

Most nut consumption is in the form of peanuts, though tree nuts (walnuts, almonds, pecans, pistachios) are frequently used in cooking and as snack foods. Peanuts are also an important source of vegetable protein. Many nuts (e.g. peanuts, almonds, cashews) are sold with added salt as snack foods; thus, the recommendations for consumption are limited to unsalted nuts as a means to reduce sodium intake. It also is important to note that nuts should be consumed in small portions, as they are high in calories and can contribute to weight gain.

Question 11. What are the Health Effects Related to Consumption of Chocolate?

Conclusion

Moderate evidence suggests that modest consumption of dark chocolate or cocoa is associated with health benefits in the form of reduced CVD risk. Potential health benefits need to be balanced with caloric intake.

Implications

Chocolate as currently consumed is a small component of the total diet, and benefits or risks will likely be minimal. Potential health effects need to be balanced with caloric intake, as chocolate is a calorie dense product. The predominant fat in chocolate is stearic acid, which has been shown to not raise blood cholesterol. Different formulations of chocolate vary in their content of dairy fat, with darker chocolate containing less dairy fat. Beneficial effects of chocolate have been attributed to polyphenolic compounds, in particular flavonoids. Many plant-based foods contain polyphenolic compounds and chocolate is a minor source. Formulations of chocolate are known to have different polyphenolic profiles, and, if this is the mechanism of chocolate's beneficial actions, different forms of chocolate may confer different benefits.

SECTION 4: PROTEIN

Question 1. What is the Relationship between the Intake of Animal Protein Products and Selected Health Outcomes?

Conclusion

Limited evidence from prospective cohort studies show inconsistent relationships between intake of animal protein products and CVD with somewhat more positive evidence for processed meats and CHD. Moderate evidence found no clear association between intake of animal protein products and blood pressure in prospective cohort studies. Limited inconsistent evidence from prospective cohort studies suggests that intake of animal protein products, mainly processed meat, may have a link to type 2 diabetes. Insufficient evidence is available to link animal protein intake and body weight. Moderate evidence reports inconsistent positive associations between colorectal cancer and the intake of certain animal protein products, mainly red and processed meat. Limited evidence shows that intake of animal protein products are associated with prostate cancer incidence. Limited evidence from cohort studies shows there is no association between the intake of animal protein products and overall breast cancer risk. However in subgroups of breast cancer patients, limited evidence suggested a relationship between the intake of animal protein products and risk of developing breast cancer.

Implications

Americans may choose animal products as part of their diet based on the body of evidence showing a general lack of relationship between animal protein consumption and selected health outcomes. However, attention should be given to quantity and preparation, as some forms of meat (well done

and processed) may be linked to specific cancers. In addition, animal protein products contain saturated fat and proportionately, a high calorie load, so serving sizes should be appropriate.

Question 2: What is the Relationship between Vegetable Protein and/or Soy Protein and Selected Health Outcomes?

Conclusion

Few studies are available, and the limited body of evidence suggests that vegetable protein intake does not offer special protection against type 2 diabetes, coronary heart disease, and selected cancers. Moderate evidence from both cohort and cross-sectional studies show that intake of vegetable protein is generally linked to lower blood pressure. Moderate evidence suggests soy protein intake may have small effects on total and low density lipoprotein cholesterol in adults with normal or elevated blood lipids, although results from systematic reviews are inconsistent. A moderate body of consistent evidence finds no unique benefit of soy protein intake on body weight. A limited and inconsistent body of evidence shows that soy protein intake does not provide any unique benefits in blood pressure control.

Implications

Our review indicated that intake of vegetable protein is generally linked to lower blood pressure, but this could be due to other components in plant foods, such as fiber, or other nutrients. Individual sources of vegetable protein have no unique health benefits so choice of plant protein sources can come from a wide range of plant-based foods. Consumption of plant proteins of lower quality is generally fine as long as calorie needs are met and effort is made to complement the incomplete vegetable proteins. Consumption of lower-quality or incomplete protein is of greater concern when protein needs are high. Thus, consumption of lower-quality vegetable protein must be carefully considered during pregnancy, lactation, and childhood. Additionally, recommendations to lower calorie intake to combat obesity by increasing plant-based food intake must be linked to cautionary messages to maintain protein total intake of sufficient quality at recommended levels.

Question 3: How Do the Health Outcomes of a Vegetarian Diet Compare to that of a Diet which Customarily Includes Animal Products?

Conclusion

Limited evidence is available documenting that vegetarian diets protect against cancer. However, it suggests that vegetarian diets, including vegan, are associated with lower BMI and blood pressure. Vegan diets may increase risk of osteoporotic fractures. The effect of vegetarian diets on cardiovascular disease, stroke, and mortality is discussed further in *Part B. Section 2: The Total Diet: Combining Nutrients, Consuming Food.*

Implications

Most people consume diets containing both animal and plant foods. Few studies exist on the nutritional or health status of vegetarians and/or vegans. Individuals who restrict their diet to plant

foods may be at risk of not getting adequate amounts of certain indispensable amino acids because the concentration of lysine, sulfur amino acids, and threonine are sometimes lower in plant than in animal food proteins. Nutrients of concern on vegan diets include calcium, iron, B₁₂, zinc, and long-chain *n*-3 fatty acids. Vegetarian diets that include complementary mixtures of plant proteins can provide the same quality of protein as that from animal protein. Education is needed for those designing diets containing complementary proteins for consumers switching to a more plant-based diet. Additionally, individuals consuming vegetarian, particularly vegan, diets should ensure adequate intake of all nutrients.

Question 4: What is the Relationship Between the Intake of Milk and Milk Products and Selected Health Outcomes?

Conclusion

Strong evidence demonstrates that intake of milk and milk products provide no unique role in weight control. Moderate evidence indicates that the intake of milk and milk products is linked to improved bone health in children. Limited evidence suggests a positive relationship between the intake of milk and milk products and bone health in adults, but results are inconsistent due to variability in outcomes considered. Moderate evidence shows that intake of milk and milk products are inversely associated with cardiovascular disease. A moderate body of evidence suggests an inverse relationship between the intake of milk and milk products and blood pressure. Moderate evidence shows that milk and milk products are associated with a lower incidence of type 2 diabetes in adults. Limited evidence is available showing intake of milk and milk products are associated with reduced risk of metabolic syndrome. Insufficient evidence is available to assess the relationship between intake of milk and milk products and serum cholesterol levels.

Implications

Currently, many children and adults are not consuming adequate amounts of milk and milk products. National Health and Nutrition Examination Survey (NHANES) 2005-2006 reported that the mean consumption of calcium does not meet the recommended Dietary Reference Intakes for any age group older than age 12. Research since 2004 shows that the under-consumption of milk and milk products may lead to an increase in cardiovascular disease and type 2 diabetes, as well as an increased risk for poor bone health and related diseases.

Consumption of the recommended daily amounts of low-fat or fat-free milk and milk products (2 cups for children ages 2 to 8 years, 3 cups for those ages 9 years and older) should be promoted. It is especially important to establish milk drinking in young children, as those who consume milk as children are more likely to do so as adults. Those who choose not to consume milk and milk products should include other foods in the diet that contain the nutrients provided by the milk and milk products group, protein, calcium, potassium, magnesium, Vitamin D, and Vitamin A.

Question 5: What is the Relationship between the Intake of Cooked Dry Beans and Peas and Selected Health Outcomes?

Conclusion

Limited evidence exists to establish a clear relationship between intake of cooked dry beans and peas and body weight. There is limited evidence that intake of cooked dry beans and peas lowers serum lipids. Limited evidence is available to determine a relationship between the intake of cooked dry beans and peas and type 2 diabetes.

Implications

Legumes and soybeans, including dried beans and peas, are typically recommended foods because of their content of dietary fiber, protein, vitamins, and minerals (Mesina, 1999). Because soybeans are particularly high in isoflavones, a phytoestrogen, they have been more extensively studied than other legumes. Legumes are also promoted as a complementary protein source to grains since legumes are low in methionine and grains are low in lysine. Thus, legumes play an important role in vegan diets for enhancing protein quality. They may also provide a beneficial contribution to the general population in part to increase total vegetable consumption and dietary fiber intake.

SECTION 5: CARBOHYDRATES

Question 1: What are the Health Benefits of Dietary Fiber?

Conclusion

A moderate body of evidence suggests that dietary fiber from whole foods protects against cardiovascular disease, obesity, and type 2 diabetes and is essential for optimal digestive health.

Implications

Dietary fiber is under-consumed across all segments of the American population. The development of many risk factors that are associated with incidence of several highly prevalent chronic diseases could be reduced by increasing consumption of naturally-occurring plant-based foods that are high in dietary fiber, including whole grain foods, cooked dry beans and peas, vegetables, fruits, and nuts.

Question 2: What is the Relationship between Whole Grain Intake and Selected Health Outcomes?

Conclusion

A moderate body of evidence from large prospective cohort studies shows that whole grain intake, which includes cereal fiber, protects against cardiovascular disease. Limited evidence shows that consumption of whole grains is associated with a reduced incidence of type 2 diabetes in large prospective cohort studies. Moderate evidence shows that intake of whole grains and grain fiber is associated with lower body weight.

Implications

Currently most Americans are not consuming adequate amounts of whole grains, which are an important source of dietary fiber and other nutrients. Enriched and fortified grains provide important nutrients; hence, individuals are encouraged to consume grains as both fiber-rich whole grains and enriched grains. To ensure nutrient adequacy, especially for folate, individuals who consume all of their grains as whole grains should include some that have been fortified with folic acid.

Total grains servings are typically over-consumed in the US, so recommendations to consume more grains are not supported by this review. Advice should be to make more grain choices as fiber-rich whole grains, rather than eat more grains. The lack of standards for whole grain foods and measuring whole grain content of foods also make any recommendations difficult to implement.

Question 3: What is the Relationship Between the Intake of Vegetables and Fruits, not Including Juice, and Selected Health Outcomes?

Conclusion

Consistent evidence suggests at least a moderate inverse relationship between vegetable and fruit consumption with myocardial infarction and stroke, with significantly larger, positive effects noted above five servings of vegetables and fruits per day. Notwithstanding prior work on dietary patterns that emphasize vegetables and fruits, insufficient evidence published since 2004 is available to assess the independent relationship between vegetable and fruit intake and blood pressure or serum cholesterol. The evidence for an association between increased fruit and vegetable intake and lower body weight is modest with a trend towards decreased weight gain over 5+ years in middle adulthood. No conclusions can be drawn from the evidence on the efficacy of increased fruit and vegetable consumption in weight loss diets. Limited and inconsistent evidence suggests an inverse association between total vegetable and fruit consumption and the development of type 2 diabetes. Evidence also indicates that some types of vegetables and fruits are probably protective against some cancers.

Implications

Vegetables and fruits are nutrient-dense and relatively low in calories. In order to meet the recommended intakes, Americans should emphasize vegetables and fruits in their daily food choices, without added solid fats, sugars, starches or sodium to maximize health benefits. Significant favorable associations between vegetable and fruit consumption and health outcomes appear to be linked to a minimum of five servings per day and positive linear effects may be noted at even higher consumption levels. While the impact of increased vegetable and fruit consumption per se is unclear for some chronic diseases and markers (blood lipids, glucose control, type 2 diabetes, and weight loss), improvements in preventing cardiovascular disease and certain cancers, especially cancers of the alimentary tract, may occur with increased consumption of these foods. Additionally, there is evidence that vegetables and fruits, when considered as part of a dietary pattern, are associated with improved weight and health outcomes (see *Part D. Section 2: The Total Diet: Combining*

Nutrients, Consuming Food for a discussion of dietary patterns and *Part D. Section 1: Energy Balance and Weight Management* for a discussion of energy density).

Question 4: What is the Relationship between Glycemic Index or Glycemic Load and Body Weight, Type 2 Diabetes, Cardiovascular Disease, and Cancer?

Conclusion

Strong and consistent evidence shows that glycemic index and/or glycemic load are not associated with body weight and do not lead to greater weight loss or better weight maintenance. Abundant, strong epidemiological evidence demonstrates that there is no association between glycemic index or load and cancer. A moderate body of inconsistent evidence supports a relationship between high glycemic index and type 2 diabetes. Strong, convincing evidence shows little association between glycemic load and type 2 diabetes. Due to limited evidence, no conclusion can be drawn to assess the relationship between either glycemic index or load and cardiovascular disease.

Implications

When selecting carbohydrate foods, there is no need for concern with their glycemic index or glycemic load. What is important to heed is their calories, caloric density, and fiber content.

Question 5: In Adults, What Are the Associations between Intake of Sugar-sweetened Beverages and Energy Intake and Body Weight?

Conclusions

Limited evidence shows that intake of sugar-sweetened beverages is linked to higher energy intake in adults. A moderate body of epidemiologic evidence suggests that greater consumption of sugar-sweetened beverages is associated with increased body weight in adults. A moderate body of evidence suggests that under isocaloric controlled conditions, added sugars, including sugar-sweetened beverages, are no more likely to cause weight gain than any other source of energy.

Implications

Added sugars, as found in sugar-sweetened beverages (SSB), are not different than other extra calories in the diet for energy intake and body weight. Thus, reducing intake of all added sugars, including sucrose, corn sweetener, fructose, high fructose corn syrup, and other forms of added sugars, is a recommended strategy to reduce calorie intake in Americans. Intake of caloric beverages, including SSB, sweetened coffee and tea, energy drinks, and other drinks high in calories and low in nutrients should be reduced in consumers needing to lower body weight. While still moderate, recent evidence is stronger than prior evidence available to assess the relationship between sugar-sweetened beverages and increased body weight.

Question 6: How are Non-caloric Sweeteners Related to Energy Intake and Body Weight?

Conclusion

Moderate evidence shows that using non-caloric sweeteners will affect energy intake only if they are substituted for higher calorie foods and beverages. A few observational studies reported that individuals who use non-caloric sweeteners are more likely to gain weight or be heavier. This does not mean that non-caloric sweeteners cause weight gain, but rather that they are more likely to be consumed by overweight and obese individuals.

Implications

The replacement of sugar-sweetened foods and beverages with sugar-free products should theoretically reduce body weight. Yet many questions remain, as epidemiologic studies show a positive link with use of nonnutritive sweeteners and BMI. Additionally, whether use of low calorie sweeteners is linked to higher intake of other calories in the diet remains a debated question.

Question 7: What is the Impact of Liquid Versus Solid Foods on Energy Intake and Body Weight?

Conclusion

A limited body of evidence shows conflicting results about whether liquid and solid foods differ in their effects on energy intake and body weight except that liquids in the form of soup may lead to decreased energy intake and body weight.

Implications

In general, if total calorie content is held constant, there is little support for any effects on energy intake and body weight due to the calories consumed either as liquid or solid. Some studies suggest that whole foods may be more satiating than liquid foods. Food structure, specifically a whole food (apple, carrots), plays a role in satiety and decreasing food intake at subsequent meals, yet fiber added to a drink is not effective in reducing food intake at subsequent meals. Soup as a preload decreases food intake at a subsequent meal. Thus, Americans are advised to pay attention to the calorie content of the food or beverage consumed, regardless of whether it is a liquid or solid. Calories are the issue in either case.

Question 8: What is the Role of Carbohydrate, Fiber, Protein, Fat, and Food Form on Satiety?

Conclusion

Many factors affect satiety and most studies are conducted in laboratory settings to control for variables. Thus results may not be generalized to the more complicated eating environment of the outside world. Foods high in dietary fiber generally are more satiating than low fiber foods, although some fibers added to drinks have little impact on satiety. Overall, small changes in the macronutrient content of the diet do not significantly alter satiety.

Implications

Intakes of caloric preloads, whether carbohydrate, protein, or fat, typically increase satiety. Protein and carbohydrate may be more satiating than fat, although studies are not consistent. Dietary fiber, especially from whole foods, appears to enhance satiety in studies. Not all fibers added to beverages or foods are equally satiating. In fact, some functional fibers show no effect on satiety.

Question 9: What is the Role of Prebiotics and Probiotics in Health?**Conclusion**

Gut microflora play a role in health, although the research in this area is still developing. Foods high in prebiotics (wheat, onions, garlic) may be consumed, as well as food concentrated in probiotics (yogurt), within accepted dietary patterns.

Implications

The lack of epidemiologic studies that support a role for changes in gut microflora and health outcomes limits any specific dietary recommendations in this area. Foods high in prebiotics and probiotics are linked to health benefits. For example, fiber is a prebiotic linked to health benefits. Many probiotic-containing foods, such as dairy foods, also are linked to health benefits and are recommended for inclusion in the diet.

SECTION 6: SODIUM, POTASSIUM, AND WATER**Question 1: What is the Effect of Sodium Intake on Blood Pressure in Children and in Adults?****Conclusion**

A strong body of evidence has documented that in adults, as sodium intake decreases, so does blood pressure. A moderate body of evidence has documented that as sodium intake decreases, so does blood pressure in children, birth to 18 years of age.

Implications

The projected health benefits of a reduced sodium intake are substantial and include fewer strokes, cardiovascular disease events, and deaths, as well as substantially reduced health care costs. In view of these potential benefits and the current very high intake of sodium in the general population, children and adults should lower their sodium intake as much as possible by consuming fewer processed foods that are high in sodium, and by using little or no salt when preparing or eating foods.

The current food supply is replete with excess sodium. Many foods contribute to the high intake of sodium. While some foods are extremely high in sodium, the problem of excess sodium reflects frequent consumption of foods that are only moderately high in sodium. The major sources of sodium intake among the US population are yeast breads; chicken and chicken mixed dishes; pizza;

pasta and pasta dishes; cold cuts; condiments; Mexican mixed dishes; sausage, franks, bacon, and ribs; regular cheese; grain-based desserts; soups; and beef and beef mixed dishes (NCI, 2010). Collectively, this group of foods contributes about 56 percent of the dietary sodium, or nearly 2000 mg per person per day.

A major new concern is the excessive sodium added to products such as poultry, pork and fish through injections or marination; efforts to quantify the amount of sodium from this type of processing are warranted. Finally, an important determinant of sodium intake is calorie intake. Hence, efforts to reduce calorie intake should also lower sodium intake.

In 2005, the DGAC recommended a daily sodium intake of less than 2,300 mg for the general adult population and stated that hypertensive individuals, Blacks, and middle-aged and older adults would benefit from reducing their sodium intake even further. Because these latter groups together now comprise nearly 70 percent of US adults, the goal should be 1,500 mg per day for the general population. Given the current US marketplace and the resulting excessively high sodium intake, it will be challenging to achieve the lower level. In addition, time is required to adjust taste perception in the general population. Thus, the reduction from 2,300 mg to 1,500 mg per day should occur gradually over time. A recent Institute of Medicine report has provided a roadmap to achieve gradual reductions in sodium intake. Because early stages of blood pressure-related atherosclerotic disease begin during childhood, both children and adults should reduce their sodium intake. Individuals should also increase their consumption of dietary potassium because increased potassium intakes helps to attenuate the effects of sodium on blood pressure.

Question 2: What is the Effect of Potassium Intake on Blood Pressure in Adults?

Conclusion

A moderate body of evidence has demonstrated that a higher intake of potassium is associated with lower blood pressure in adults.

Implications

Increasing dietary potassium intake can lower blood pressure. A higher intake of potassium also attenuates the adverse effects of sodium on blood pressure. Other possible benefits include a reduced risk of developing kidney stones and decreased bone loss. In view of the health benefits of adequate potassium intake and its relatively low current intake by the general population, increased intake of dietary potassium is warranted. The IOM set the AI for potassium for adults at 4,700 mg per day. Available evidence suggests that Blacks and hypertensive individuals especially benefit from an increased intake of potassium.

Question 3. What Amount of Water is Recommended for Health?

Conclusion

Based on an extensive review of evidence, an IOM panel in 2004 concluded that the combination of thirst and usual drinking behavior, especially the consumption of fluids with meals, is sufficient to

maintain normal hydration. However, because water needs vary considerably and because there is no evidence of chronic dehydration in the general population, a minimum intake of water cannot be set.

Implications

In order to prevent dehydration, water must be consumed daily. Healthy individuals who have routine access to fluids and who are not exposed to heat stress consume adequate water to meet their needs. Purposeful drinking is warranted for individuals who are exposed to heat stress or who perform sustained vigorous physical activity. Although uncommon, heat waves are one setting of extreme heat stress that increases the risk of morbidity and mortality from dehydration, especially in older-aged persons. In view of the ongoing obesity epidemic, individuals are encouraged to drink water and other fluids with few or no calories.

SECTION 7: ALCOHOL

Question 1. What is the Relationship between Alcohol Intake and Weight Gain?

Conclusion

Moderate evidence suggests that among free-living populations, moderate drinking is not associated with weight gain. However, heavier consumption over time is associated with weight gain.

Implications

Regardless of the alcoholic beverage, in general, all contain calories that are not a good source of nutrients and when consumed beyond an average of two drinks a day may lead to weight gain. Below this level of consumption, the results from most well designed large prospective studies suggest that individuals who drink in moderation do not gain weight at a faster rate than non-drinkers.

Question 2: What is the Relationship between Alcohol Intake and Cognitive Decline with Age?

Conclusion

Moderate evidence suggests that compared to non-drinkers, individuals who drink moderately have a slower cognitive decline with age. Although limited, evidence suggests that heavy or binge drinking is detrimental to age-related cognitive decline.

Implications

Alcohol, when consumed in moderation, did not quicken the pace of age-related loss of cognitive function. In most studies, it was just the opposite—moderate alcohol consumption, when part of a healthy diet and physical activity program, appeared to help to keep cognitive function intact with age. Despite the potential benefit at moderate consumption levels, heavy drinking and episodes of binge drinking impairs short- and long-term cognitive function and should be avoided.

Question 3: What is the Relationship between Alcohol Intake and Coronary Heart Disease?

Conclusion

Strong evidence consistently demonstrates that compared to non-drinkers, individuals who drink moderately have lower risk of CHD. Insufficient evidence was available to determine if any one single drinking pattern was predictive of lower or higher risk of coronary heart disease, although there was moderate evidence to suggest that heavy or binge drinking is detrimental.

Implications

An average daily intake of one to two alcoholic beverages is associated with a low risk of CHD among middle-aged and older adults. Binge or heavy irregular drinking should be avoided.

Question 4: What is the Relationship between Alcohol Intake and Bone Health?

Conclusion

Moderate evidence suggests a J-shaped association between alcohol consumption and incidence of hip fracture; there was a suggestion that heavy or binge drinking was detrimental to bone health.

Implications

There is insufficient evidence from epidemiological data to make a strong conclusion related to patterns of alcohol intake and bone health. However, it is very likely that the increased risk of fracture among individuals who drink more than one to two drinks per day on average is due to injuries that follow heavier consumption. What further complicates the interpretation of the existing studies is that moderate and heavy drinkers frequently were combined in the same category, making it impossible to disentangle potential benefits and risks. In addition, many studies failed to control adequately for physical activity, an important lifestyle characteristic beneficially related to bone density.

Question 5: What is the Relationship between Alcohol Intake and Unintentional Injury?

Conclusion

Strong evidence demonstrates that drinking in excess of current guidelines increases the risk of unintentional falls, motor vehicle crashes, and drowning. When alcohol is consumed in moderation, the evidence for risk of unintentional injury is less well established for activities such as driving, swimming, and athletic participation, but abstention from alcohol is the safest.

Implications

Adverse effects, in terms of unintentional injury, can occur even at levels of moderate alcohol consumption.

Question 6. Does Alcohol Consumption during Lactation have Adverse Health Effects? What is the Relationship between Alcohol Consumption and the Quality and Quantity of Breast Milk Available for the Offspring? What is the Relationship between Alcohol Consumption and Postnatal Growth Patterns, Sleep Patterns, and/or Psychomotor Patterns of the Offspring?

Conclusion

Moderate, consistent evidence shows that when a lactating mother consumes alcohol, alcohol enters the breast milk, and the quantity of milk produced is reduced, leading to reduced milk consumption by the infant. Although limited, evidence suggests that alcohol consumption during lactation was associated with altered post-natal growth, sleep patterns, and/or psychomotor patterns of the offspring.

Implications

The benefits of breastfeeding to the infant are well established. A woman who chooses to breast feed, however, need not completely abstain from alcohol. Because the level of alcohol in breast milk mirrors the mother's blood alcohol content, after latch-on has been perfected and a pattern of consistent breastfeeding has been established (i.e., around age 2 to 3 months), a mother could wait 3 to 4 hours after a single drink (the time it would take to metabolize the ethanol) before breastfeeding and the infant exposure to alcohol would likely be negligible. It is not sufficient for a woman to express breast milk after alcohol consumption to prevent exposure to the infant because the concentration of alcohol in breast milk will remain at levels in the blood until all the alcohol is metabolized. Contrary to medical and cultural folklore, alcohol consumption does not enhance lactational performance and instead reduces milk production and decreases infant milk consumption in the 3 to 4 hours after alcohol is consumed. Finally, there is still insufficient evidence to conclude definitively that alcohol exposure to an infant during lactation affects the postnatal growth of the child, but nonetheless alcohol exposure to the breastfeeding infant by breastfeeding too soon after consuming a single drink should be avoided.

SECTION 8: FOOD SAFETY AND TECHNOLOGY

BEHAVIORS MOST LIKELY TO PREVENT FOOD SAFETY PROBLEMS AND THE EXTENT TO WHICH US CONSUMERS FOLLOW THESE BEHAVIORS

Overarching Conclusion

Evidence shows that proper hand sanitation techniques, proper washing of vegetables and fruit, prevention of cross-contamination, and appropriate cooking and storage of foods in the home kitchen are most likely to prevent food safety problems. Food safety behaviors least practiced by consumers are hand sanitation, cross-contamination prevention, and use of cooking, refrigerator, and freezer thermometers. Food safety knowledge of US consumers is not being translated into improved food safety practices at home.

Implications

All segments of the US population could benefit from improved food safety education based on effective behavioral change theories. Food safety education is needed to not only improve consumers' knowledge, but also their attitudes and intentions toward reducing home-based food safety risks. In particular, consumers need to take more responsibility regarding food safety. Together, with sound government policies and responsible food industry practices, foodborne illness can be prevented.

Food safety behaviors that particularly need additional promotion are hand sanitation, use of cooking and refrigerator/freezer thermometers, and prevention of cross-contamination. Produce washing practices can vary significantly for different vegetables and this behavior needs to be substantially improved. Additional guidance is needed to provide detailed recommendations on the frequency of refrigerator cleaning to decrease pathogen growth and potential for cross-contamination. It is important to educate consumers on appropriate cooking temperatures and the reasons to avoid consuming raw or undercooked animal protein products. The consumption of certain risky foods (e.g., cookie dough containing raw eggs) is likely to occur at home, but the consumption of other foods (e.g., raw seafood) is more likely to occur outside the home. Thus, consumer food safety education in this area needs to address safe food practices in the different environments in which individuals are likely to consume the different products. Education should also address food safety issues that have emerged due to trends toward local- and regional-based food production.

Of subpopulations in the US, older adults may be at greater risk because of the age-related reduction in immunity. Pregnant women also have altered immune status which may render the fetus more susceptible to infection. Foodborne illnesses affecting pregnant women can have extremely serious consequences for the fetus as illustrated by the still births resulting from listeriosis. Foodborne illness outbreaks among college students have the potential to rapidly spread within the student body as a result of the group arrangements in which they often live.

Question 1. CLEAN: What Techniques for Hand Sanitation are Associated with Favorable Food Safety Outcomes and to What Extent Do US Consumers Follow Them?

Conclusion

Strong, clear, and consistent evidence shows that hand washing with plain soap for 20-30 seconds followed by proper hand drying is an effective hand hygiene technique for preventing cross-contamination during food preparation. Strong, clear, and consistent evidence shows that alcohol-based, rinse-free hand sanitizers are an adequate alternative when proper hand washing with plain soap is not possible. Moderate, consistent evidence shows that US consumers do not follow recommended hand sanitation behaviors.

Question 2. CLEAN: What Techniques for Washing Fresh Produce are Associated with Favorable Food Safety Outcomes and to What Extent Do US Consumers Follow Them?

Conclusion

A limited body of evidence has shown that washing vegetables and fruit by running water over them at home or under laboratory simulation conditions is associated with reduced produce microbial loads. Moderate, consistent evidence shows that US consumers are not following recommended produce washing techniques at home.

Question 3. CLEAN: To What Extent Do US Consumers Clean Their Refrigerators?

Conclusion

Moderate, consistent evidence shows that US consumers do not clean their refrigerators following available guidance.

Question 4. SEPARATE: What Techniques for Preventing Cross-Contamination are Associated with Favorable Food Safety Outcomes?

Conclusion

Moderate, consistent evidence indicates that preventing cross-contamination in the home kitchen may reduce exposure to foodborne pathogens among US consumers. Techniques associated with favorable food safety outcomes for preventing cross-contamination include proper cleaning of food preparation surfaces and/or cooking utensils, particularly cutting boards and cutlery, accompanied by hand washing.

Question 5. COOK AND CHILL: To What Extent Do US Consumers Follow Adequate Temperature Control During Food Preparation and Storage at Home?

Conclusion

Strong, consistent evidence shows that the great majority of US consumers do not use food thermometers to properly assess the internal cooking temperature of meat and poultry while cooking. Moderate, consistent evidence shows that US consumers lack refrigerator and freezer thermometers in their homes.

Question 6. RISKY FOODS: To What Extent Do US Consumers Eat Raw or Undercooked Animal Foods?

Conclusion

Moderate, clear, and consistent evidence shows that the consumption of raw or undercooked animal-source food products is relatively common in the US, especially for eggs and egg-containing products, and ground beef products.

Question 7. To What Extent Do Specific Subpopulations Practice Unsafe Food Safety Behaviors?

Conclusion

Moderate available evidence, which focused on pregnant women, college students, and older adults, shows that these populations commonly practice unsafe food handling and consumption behaviors.

FOOD SAFETY TECHNOLOGIES

Question 8. To What Extent are Recently Developed Technological Materials that are Designed to Improve Food Safety Effective in Reducing Exposure to Pathogens and Decreasing the Risk of Foodborne Illnesses in the Home?

Conclusion

A limited body of inconsistent evidence describes and evaluates contributions to or advances of food safety modalities or practices in the home. These small studies indicate the correct usage of these kinds of products is critical for assessing proper cooking temperature and ensuring adequate reduction of microbial burden on food contact surfaces. Not all thermometers tested, wipes assessed, and sanitizers evaluated were accurate or effective in providing correct cook temperatures or assuring consistent safety against typical foodborne organisms.

Implications

New and emerging technologies over the past 5 years can assist consumers in preserving and protecting foods while encouraging safe food handling practices in the home; however, appropriate techniques for using products is essential in the efficacy of decreasing the risk for foodborne illness. The evidence supporting emerging food safety technologies in the home is limited, despite the emergence of commercial tools and appliances intended to improve safe food handling and management practices in the home. Consumers should adhere to food safety fundamentals in the home, which will remain foundational, even with future introductions of food safety technologies.

SEAFOOD

Question 9. What are the Benefits in Relationship to the Risks for Seafood Consumption?

Conclusion

Moderate, consistent evidence shows that health benefits derived from the consumption of a variety of cooked seafood in the US in amounts recommended by the Committee outweigh the risks associated with methyl mercury (MeHg) and persistent organic pollutants (POPs) exposure, even among women who may become or who are pregnant, nursing mothers, and children ages 12 and younger. Overall, consumers can safely eat at least 12 oz. of a variety of cooked seafood per week provided they pay attention to local seafood advisories and limit their intake of large, predatory fish. Women who may become or who are pregnant, nursing mothers, and children ages 12 and younger can safely consume a variety of cooked seafood in amounts recommended by this Committee while following Federal and local advisories.

Implications

Seafood is a healthy food choice that can be safely promoted provided that the types and sources of seafood to be limited or avoided by some consumers are clearly communicated to consumers. Consumers may be able to eat safely more than 12 oz. per week of seafood if they chose to do so provided they choose the right mix of seafood that emphasizes the consumption of seafood species with relatively low concentrations of contaminants such as MeHg and POPs. Encouraging consumption of seafood in the US is justified, as consumption continues to be far below amounts recommended for health by the Institute of Medicine and by this Committee (see *Part D. Section 3: Fatty Acids and Cholesterol*).

Current Federal advisories on consumption of seafood species with high MeHg levels that vulnerable groups need to avoid are well justified by the scientific evidence. Regarding women who may become or who are pregnant, nursing mothers, and young children, there is emerging evidence that consumption beyond 12 oz. per week may be safe. However, additional benefit/risk modeling is needed taking into account the simultaneous presence of multiple contaminants in a shifting seafood supply. State and local agencies should continue to reach out to vulnerable groups and the population at large with advisories about the presence of diverse environmental contaminants in different water bodies. This is particularly relevant for seafood caught by consumers. The public also needs to be advised that eating a variety of seafood, as opposed to just a few choices, is likely to reduce their exposure to 'single source' contaminants. Clear, consistent evidence indicates that consumers will need access to publicly available user-friendly benefit/risk information to make informed seafood choices that maximize their health taking into account their seafood preferences.